THE SCIENCE TEACHER

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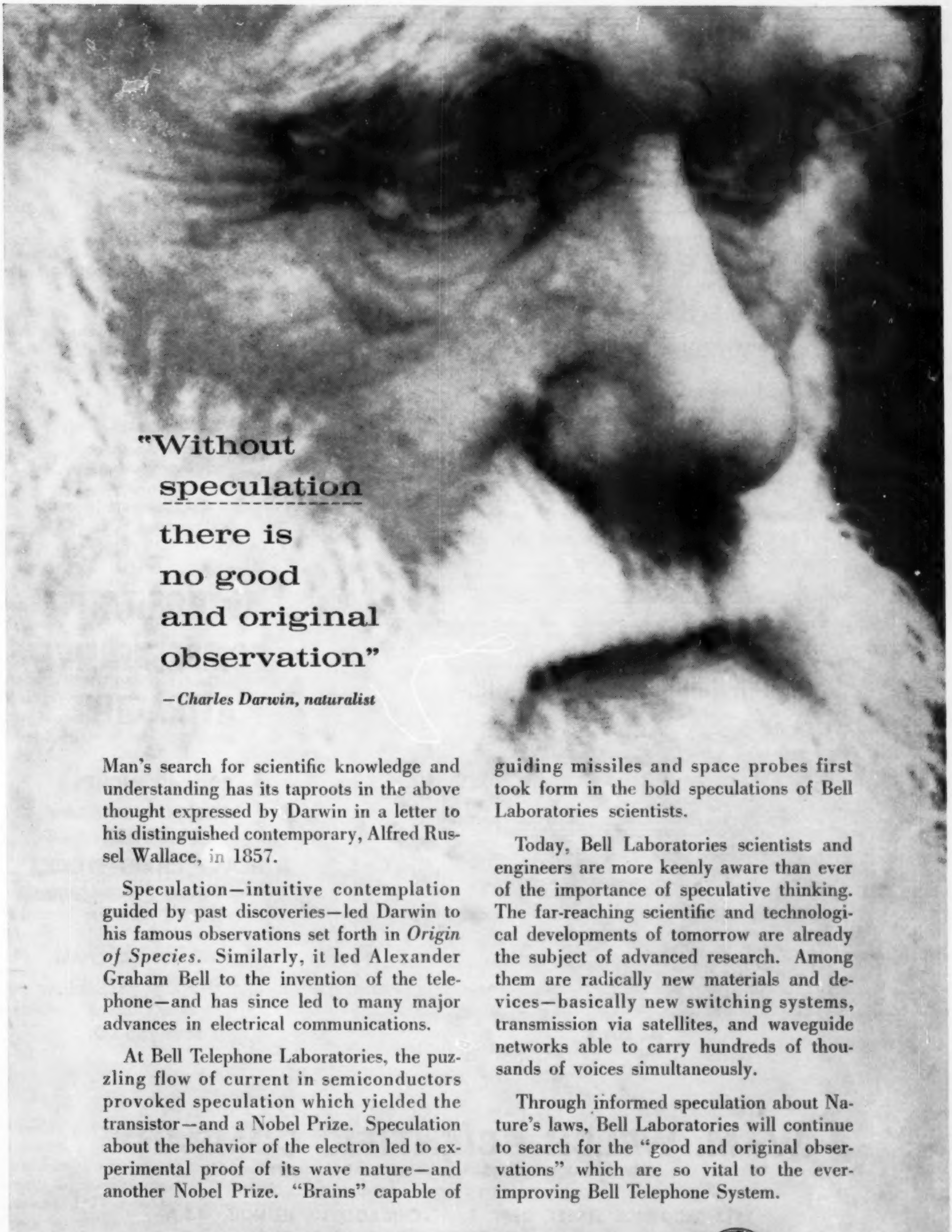
"Without speculation there is no good and original observation"
—Charles Darwin, naturalist
Man's search for scientific knowledge and understanding has its taproots in the above thought expressed by Darwin in a letter to his distinguished contemporary, Alfred Russel Wallace, in 1857.
Speculation—intuitive contemplation guided by past discoveries—led Darwin to his famous observations set forth in Origin of Species. Similarly, it led Alexander Graham Bell to the invention of the telephone—and has since led to many major advances in electrical communications.
At Bell Telephone Laboratories, the puzzling flow of current in semiconductors provoked speculation which yielded the transistor—and a Nobel Prize. Speculation about the behavior of the electron led to experimental proof of its wave nature—and another Nobel Prize. "Brains" capable of guiding missiles and space probes first took form in the bold speculations of Bell Laboratories scientists.
Today, Bell Laboratories scientists and engineers are more keenly aware than ever of the importance of speculative thinking. The far-reaching scientific and technological developments of tomorrow are already the subject of advanced research. Among them are radically new materials and devices—basically new switching systems, transmission via satellites, and waveguide networks able to carry hundreds of thousands of voices simultaneously.
Through informed speculation about Nature's laws, Bell Laboratories will continue to search for the "good and original observations" which are so vital to the ever-improving Bell Telephone System.
BELL TELEPHONE LABORATORIES
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT
BELL SYSTEM

THE SCIENCE TEACHER

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association

Volume 27, Number 8 • December 1960

Editorial

Certification for Science Teachers

It is well known that a nationwide effort is under way to overhaul and strengthen state teacher certification requirements. This is, of course, a logical result of similar efforts to upgrade teacher education programs. Certification, to serve its basic function of admitting the competent to practice, should provide legal undergirding for quality programs of teacher education. Certification, therefore, should follow, not dictate, the components of such programs. The major refinement now being sought in certification is the upgrading of requirements in the teaching fields and subjects. This movement is long overdue. The admittedly low teaching field requirements, which have existed so long in most states, probably have resulted largely from the predominance of the small high school, rather than from pressures for courses in education as has been frequently charged. Such schools, of course, assign several subjects to teachers rather than one or two. This situation has changed rapidly in recent years, but certification has lagged in adjusting.

What should be the teaching subject or field requirements for high school teachers? And how can they be secured? There is no simple answer to either question. With respect to the first, there is widespread demand for one teaching field or major in the undergraduate preparation of teachers. And this is being adopted in some states for some fields. However, the predominant trend, perhaps transitional in nature, seems to be toward preparation and certification in a teaching major and minor. There is just beginning to be a restiveness about the inadequate preparation of elementary school teachers in science. This area is ripe for reform. But the nature of the reform is not yet clearly discernible.

Regarding the second question, the potential influence of the profession and of professional associations representing specific subjects or fields in setting the requirements is strongly evident. In virtually all states, the state board or department of education, by whatever name, has legal power to fix the requirements for certification. Actually, however, in all but six states advisory bodies of some type, broadly representative of the profession, are maintained by the legal authority. These bodies, although extra-legal except in about 10 states, are extremely influential in the determination of certification requirements. The continuing problem here is to achieve accepted and workable balances among representatives of various interests in the profession.

National professional organizations, such as the National Science Teachers Association, can and should have great influence in the recommendations of these advisory bodies. How? By constant study of the needs, in curricular and legal requirements, in the fields in which they represent competence, and by the channeling of expert opinion to the advisory groups. This implies, of course, that policy-making machinery must be established by these professional associations on a continuing, not *ad hoc*, basis.

Further, it implies that time and money must be spent in the effort. The professional association that does not know its own mind, or the mind of its constituents, regarding adequate teacher education curricula and certification requirements, is not likely to exert influence on either.

Certainly one of the most hopeful, if not the most hopeful, current sign is that the subject-matter associations are abandoning their lethargy and carping and are vigorously participating in the drive to upgrade the subject-matter preparation of teachers. It would be appropriate and certainly desirable for the National Science Teachers Association to get into the act, aggressively and permanently.

T. M. Stinnett, *Executive Secretary*
National Commission on Teacher Education and Professional Standards, NEA

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Letters

The following comments have been excerpted from letters written by participants in the recent 1960 NSTA European Tour.

The trip was much more rewarding than expected. It was worth giving up my NSF grant for this year.

My plans are to go to the Chicago convention in March, and I do hope that arrangements for another European trip next year will be made. Thanks for your part in making this experience possible. It surpassed the usual planned tour.

ETHEL N. CALDWELL
Danbury High School
Danbury, Connecticut

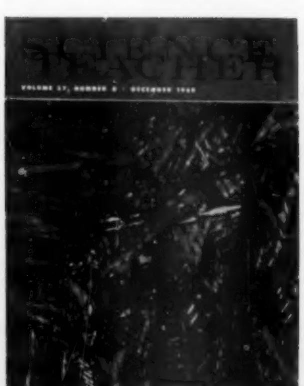
It is difficult to express my thanks for the opportunity of participating in the NSTA European Tour. No words seem adequate. The visits to scientific centers, the association with educators, and the unsurpassed scenery and historical sites are forever etched in my memory and will color my teaching for years to come. Special thanks should be expressed to you and Dr. Raskin for having the foresight to schedule such a complete tour. It was well balanced in every way.

It is my hope that you continue these tours. I should like all teachers to have this wonderful experience.

MARTHA SUE NOEL
Phillips High School
Phillips, Texas

I owe NSTA a debt of gratitude for choosing me to participate in its first International Science Study Tour. When I think of what we saw and what we did in the name of science and education, I am eternally grateful to all who participated in the tour planning and to our tour directors.

GRETA OPPE
Ball High School
Galveston, Texas



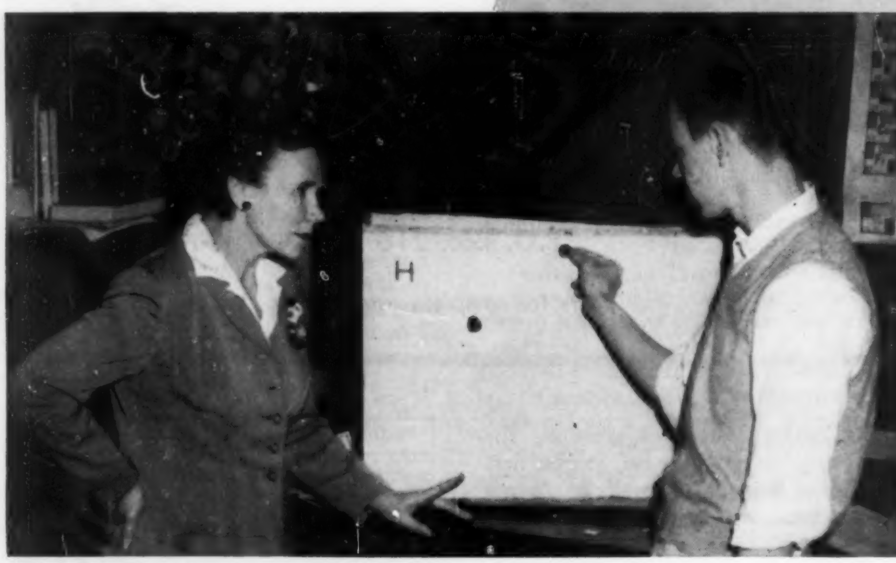
THIS MONTH'S COVER . . .

The four-color cover, a photomicrograph of a titanium-base alloy (1 per cent copper and 3 per cent lead), was made possible through the courtesy of the *Union Carbide Metals Review*, published by the Union Carbide Metals Company.

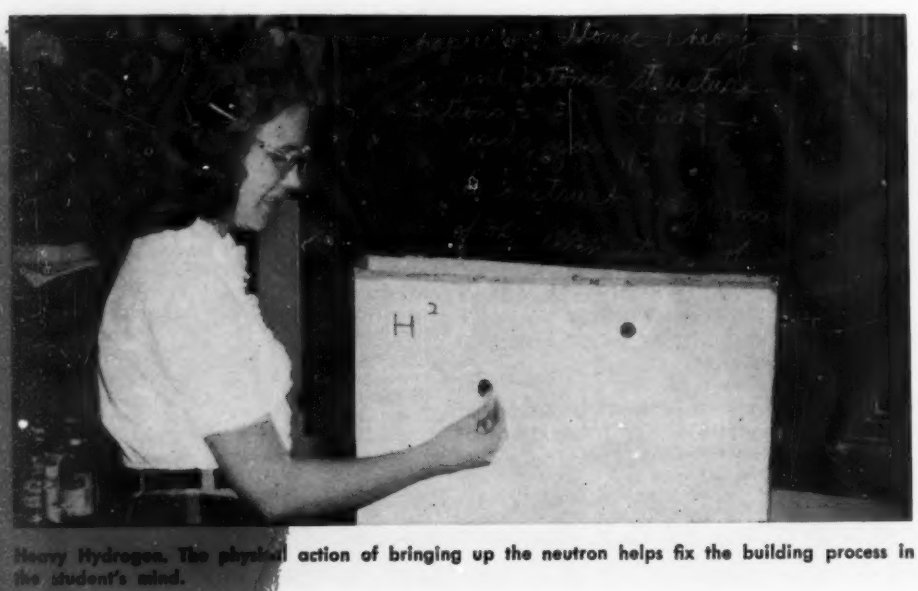
The colors—taken with reflected polarized light at a magnification of 200 diameters—arise from interference effects produced by reflection of the polarized light from the titanium crystals. Diversities are caused by variations in orientation of the martensite needles, which have a hexagonal crystal structure and are strongly anisotropic.

Flannel Board Experi

Breathes there a science teacher with soul so dead,
Who never to himself has said,
"Had I but a board such as Baxter and White,
My students would learn—
perhaps—
even the negative bright!"



The structure of Hydrogen—a brown particle to represent the proton, a red particle at some distance to represent the electron. The act of removing the electron, leaving a particle with a positive charge, gives the student the feeling of work done and has the advantage over the usual blackboard and eraser technique of keeping the electron in existence. Thus the electron is easily attracted back to the proton.



Heavy Hydrogen. The physical action of bringing up the neutron helps fix the building process in the student's mind.

This report was an entry in the 1960 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

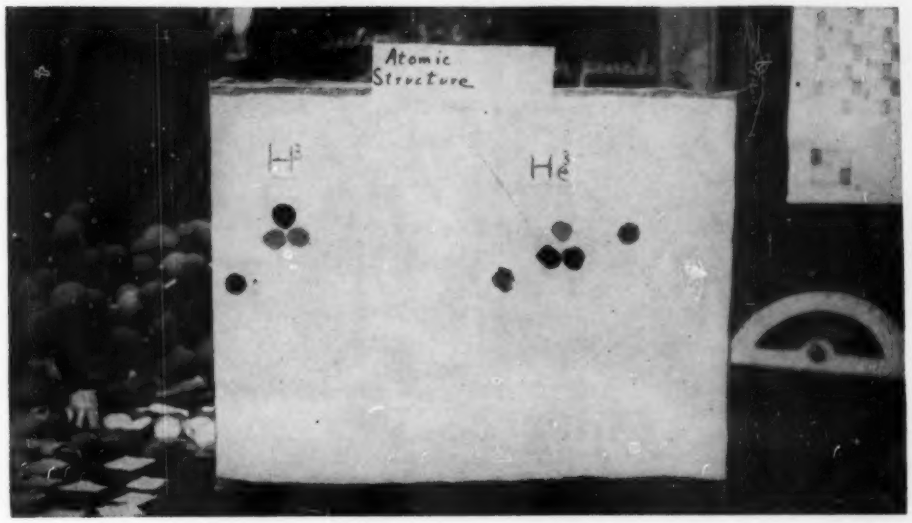
MANY of us envy the use of the excellent demonstration equipment which appears in television science programs such as *Continental Classroom*. Dr. Harvey E. White's application of the magnetic board in explaining molecular structure recalled my experiment with a flannel board to help a slow class grasp the symbolism of chemical equations. This year the fun and satisfaction which we have had with our simply constructed flannel board and the models which we continue to create—a little better each time—have certainly been worth the personal outlay of about $2.50 for materials and the few hours necessary to complete the first constructions. After the students became interested, they were willing collaborators.

As may be seen from the photographs, the equipment is obviously homemade, but because it represents efforts of the class, they accept and value it. A cardboard box about 25 by 19 by 4 inches, once a container of newsprint, has been satisfactory as a base for the piece of light yellow outing flannel. The flannel was made to adhere with a generous amount of rubber cement. The box is light and convenient to move close to the students. Yet, it has proved to be more

periments

By CATHERINE G. COLLINS

Science Teacher
Solomon Juneau High School
Milwaukee, Wisconsin

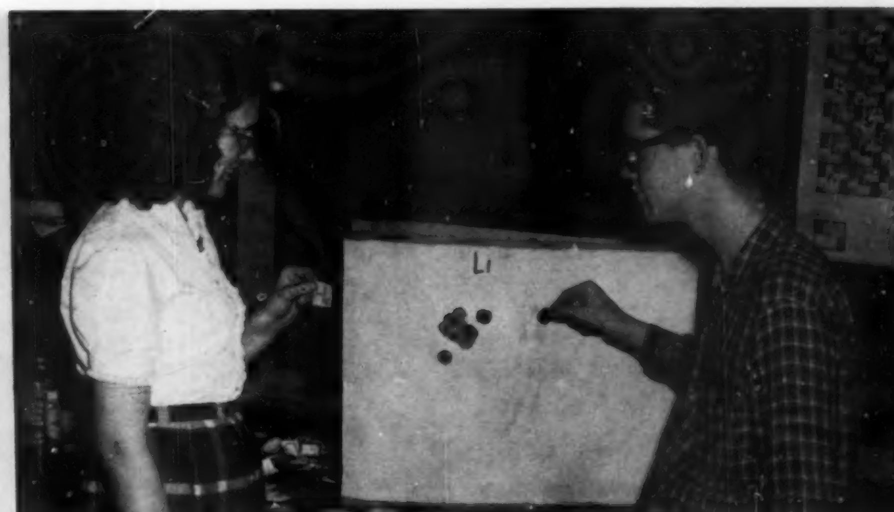


The relation between Tritium and Helium.

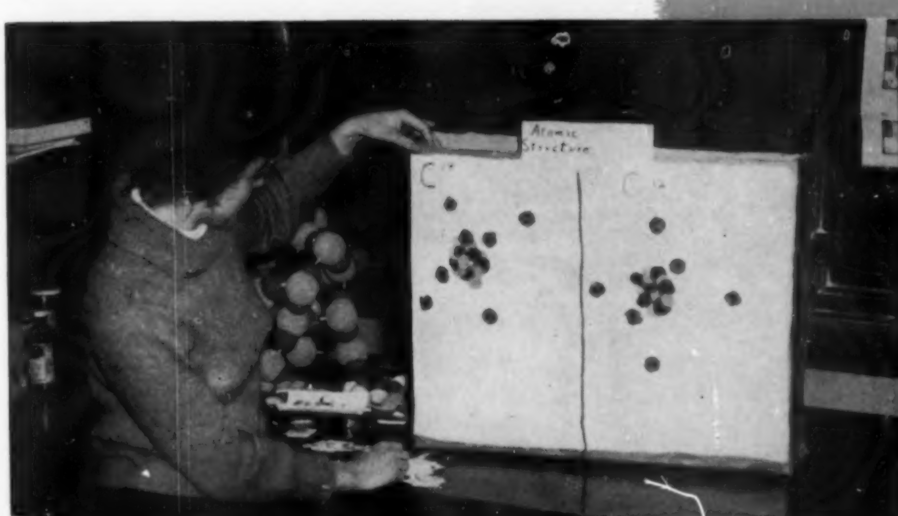
stable than its width would suggest. When not in use, the materials are conveniently stored inside a desk, the flannel board filed beside my desk—ready for another new inspiration.

The appliques may be made from flannel, felt, sandpaper, styrofoam, or specially prepared paper. Our nucleids and electrons are simply circles cut from colored flannel—brown for protons, blue for neutrons, and red for electrons. Although flannel with nap on both sides is preferred, the less expensive single nap will adhere under general conditions. The symbols were made on small squares of yellow flannel with heavy red pencil. To illustrate the formation of ions, the atomic symbol was lettered on one side and the symbol with ionic charge on the other. Some signs were lettered on paper and sewed to pieces of flannel. Our current "atoms" and "molecules" have been constructed in whole or part from pieces of styrofoam, by-products of three-dimensional models created from colored spheres.

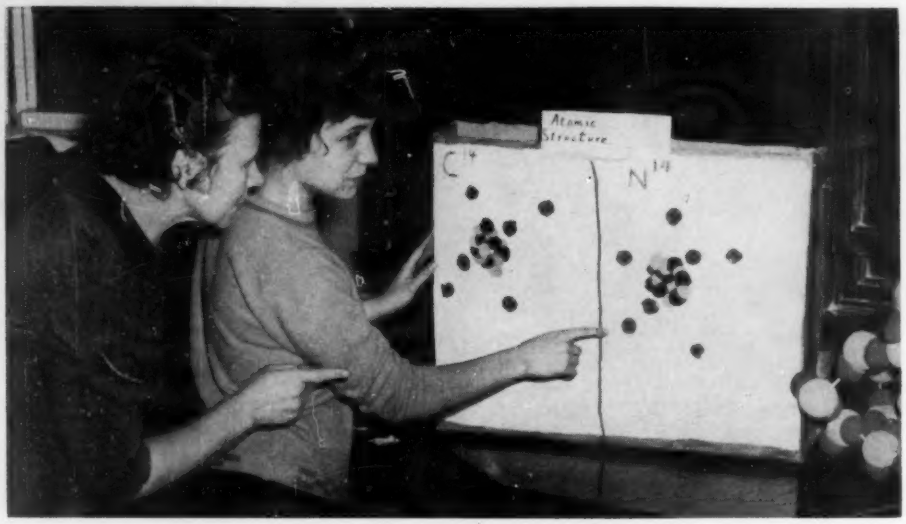
In order to understand that these pieces of flannel only partially represent a portion of our present knowledge of atomic and molecular structure, we began our study of this unit with several comparisons of relative diameters and masses of nucleids and electrons. This included one game shared with the school. A sign was placed on the wall in the cafeteria. Then a pin was mounted on the sign representing the



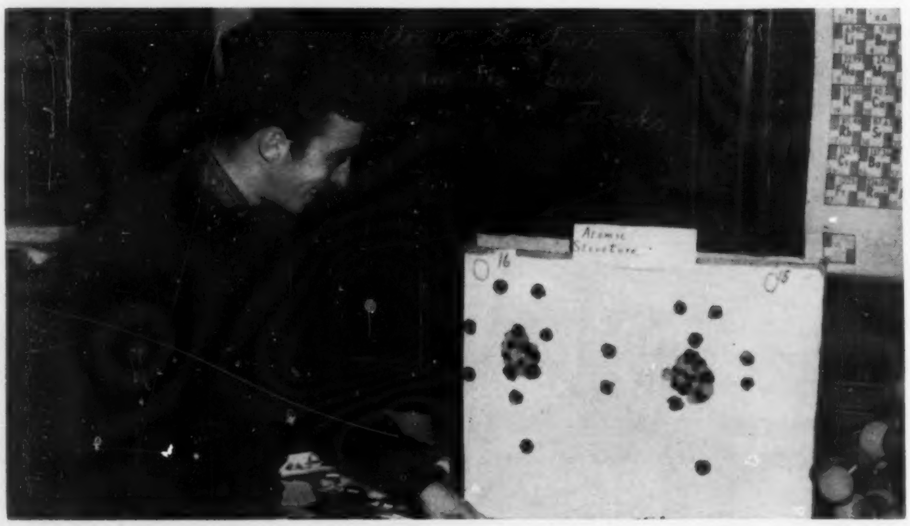
After Helium comes Lithium.



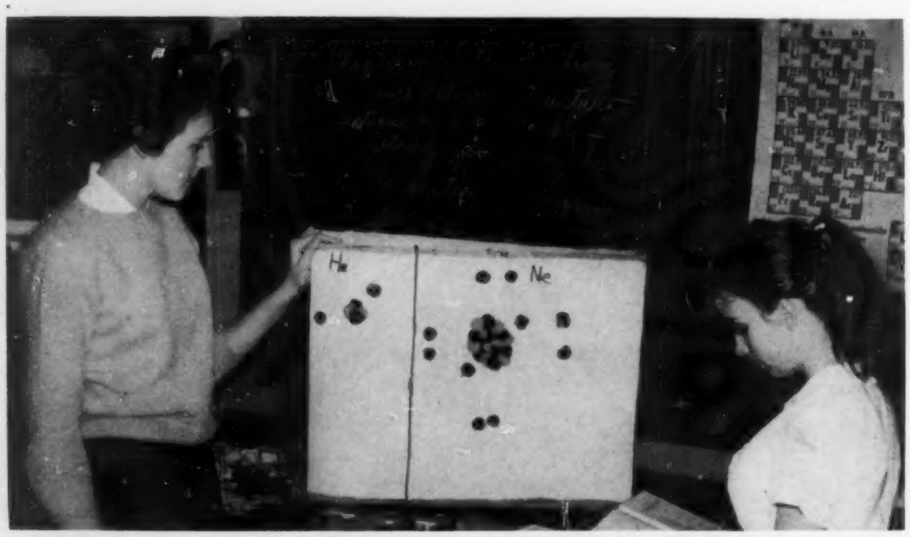
The two isotopes of Carbon differ only by two neutrons.



Carbon and Nitrogen may have the same mass but have different electron structure.



Two isotopes of Oxygen combined to form a diatomic molecule. The unpaired electron could not be predicted from our developmental approach and served as an example of the use of experiment to point the way to structure.



The structure of Helium and Neon was compared to give an understanding of ion formation.

proton nucleus of the hydrogen atom. Everyone was invited to find the "electron" which would be within or near the school building. Our electron dot was about the same size as the proton, and the student committee kept moving it each time classes were changed to simulate the vibrations of the electron. It was most often "found" down in one of the far corners of the basement—probably because it is easier to picture its position in an orbit rather than as a diffuse cloud of energy vibrating even through the nucleus itself. This exercise gave the students who helped a working acquaintance with scaling and confidence in wider use of the metric system.

Since it was inconvenient to maintain this large representation, we agreed to work with the flannel board primarily in the classroom. The width was set as approximately 10^{-12} cm, but the empty space between particles was very small. The diameter of the particles, however, was enlarged considerably. From this point we built up the atoms, the electron shells, and orbitals by consulting the periodic chart and the lists of isotopes given in our text. Even those students who felt that atomic structure was beyond them were willing to come to the front of the class and "make" the next atom. We progressed to Neon in one period, and the class assignment was to build the next series with dots in their notebooks. This was checked with more class constructions the following day. Many students came in at noon and after school to set up larger atoms. Although the chemistry classes were the principal participants, my physics classes and the ninth-grade homeroom were also interested.

One of the extra gimmicks prepared was a large-sized blue neutron (diameter about 3 cm) sewed almost all of the way around to a brown proton. Inside was stored an electron with a reinforced wave of brown material to represent a photon. This year, one boy asked about the difference in structure of the neutron and proton when we built H^3 and He^3. I had the satisfaction of presenting what I had prepared while attending a Summer Institute for Secondary School Teachers of Mathematics and Science at the Oak Ridge Institute of Nuclear Studies. Holding up the blue side for the neutron, I began pulling out the red electron followed by the wiggly photon. The sample was then turned on the other side for the crea-

tion of the brown proton. The whole class enjoyed the "magic," and four students returned later to work out the quantitative relations.

While studying the periodic table, we might have developed a color code for our families of atoms and built up a periodic chart of our own. Many such applications come to mind as one uses the board. This feeling of creativity is one of its virtues.

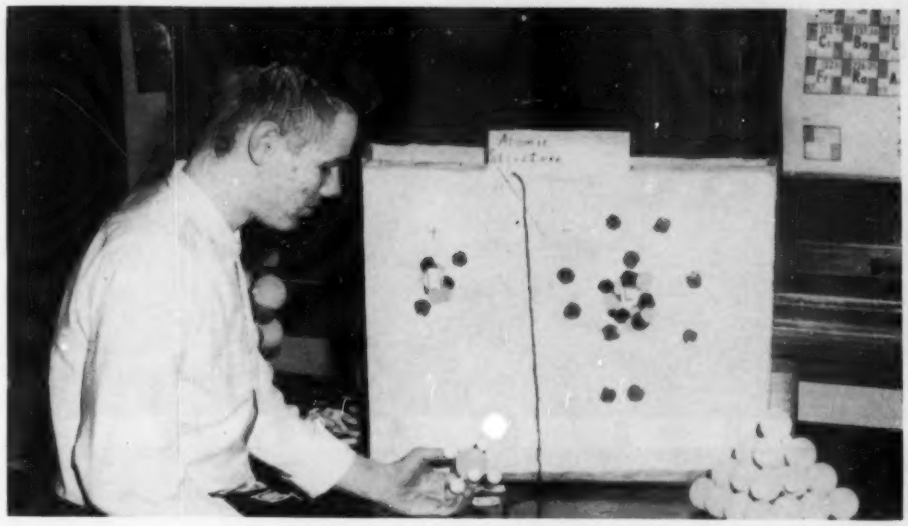
Our next step was to let the symbol represent the kernel of the atom. The red electrons represented the valence electrons. As Sodium (Na) or Calcium (Ca) lost their electrons, I could flip over the symbol to show Na^{+} or Ca^{++} and we could go back and forth as needed to make this concept clear and familiar. Sometimes we used strips of wool for the plus or minus signs. By next year we might make another board and copy Dr. Baxter's method of bringing up the Fluorine atom to the Sodium atom so that the two may react and form charged particles held at the characteristic distance determined by their structure.

Several covalent compounds were formed on the flannel board, but beyond hydrogen, chlorine, fluorine, water, hydrogen chloride, and methane, it seemed more natural to use the blackboard. (We had also become interested in three-dimensional models by this time.)

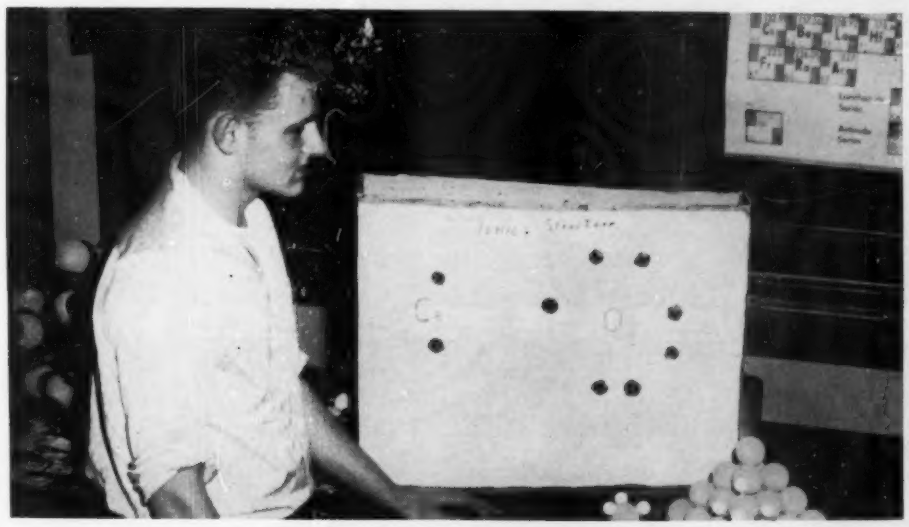
The board is practical and easy to pull out of the corner to illustrate a point or clarify a principle. For instance, while studying water, the structure of hydrates was questioned. To explain, we assembled the little blue oxygen atoms with the smaller red hydrogen atoms attached at their 105° angle. Four of these were oriented around the Copper (Cu^{++}) with the more negative oxygen toward the positive copper ion.

The reader can readily develop other ideas in his teaching methods. Students have suggested polka dot material for gas law representation and molecules on top of squares of felt, representing volumes, to help understand Avogadro's hypothesis.

If subliminal perception is a reality, perhaps leaving these brightly colored molecular groupings visible throughout several class periods will stimulate more experiments and be of considerable help in retaining the material.



The chart represents the atomic structure of Lithium and Fluorine with the ionic structures shown in the models on the table.

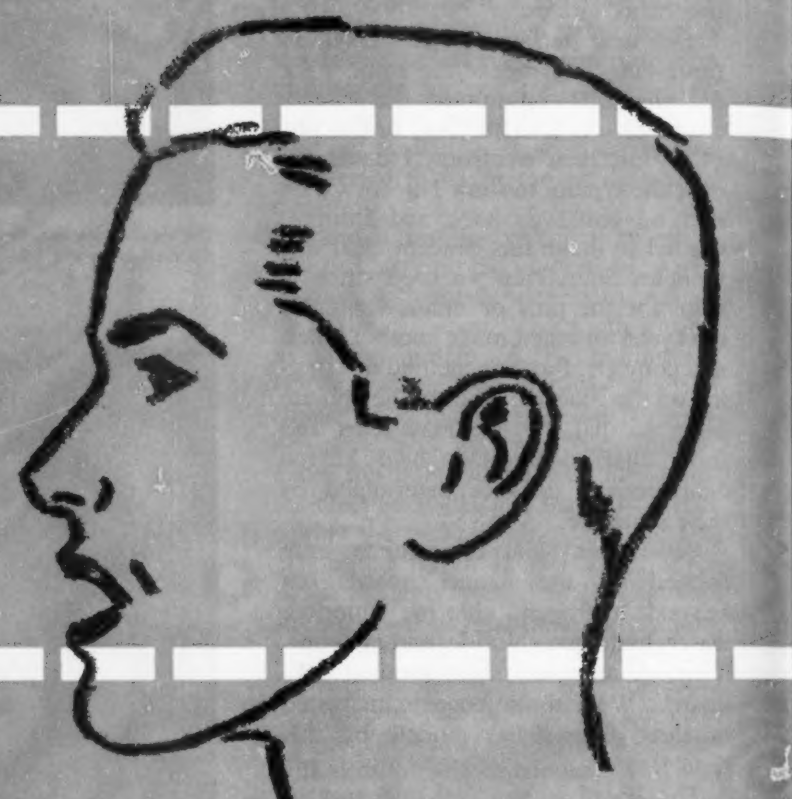


The atomic structure of Calcium and Chlorine.

The hydration of ions. The dark spheres show the closest groupings which, like water molecules, have a coordination number of six.

Effective communication, essential to the success of any educational program, poses special difficulties in science. Unless the specific vocabulary is carefully explained and fully understood, a student's learning capacity will be affected.

The following articles—one a report on a study of selected groups and the other a report on research in science communication—point up the problems facing both the teacher and his students.



Individual Study of LANGUAGE PROBLEMS

By DONALD L. HOLLEY

Instructor in English, Colorado State College, Greeley, Colorado

THE Individual Study was initiated by the author to discover the kinds of language problems faced by high school students when studying science. The investigation was also concerned with the degree of importance attached to language factors by students and teachers of scientific subjects. A language problem refers to any difficulty arising from some phase of communication, namely, reading, writing, or speaking.

The students involved were members of three groups: (1) Geneseo Senior High School, Geneseo, Illinois; (2) College High School, Greeley, Colorado; and (3) Summer Science Institute, Colorado State College, Greeley.

The members of the Summer Science Institute represented twenty-seven high schools located in Colorado and three in neighboring states. This group of thirty was essentially a select group in that members had to submit applications and prove their scientific ability and interest to become eligible for the Institute.

Many different methods were used to discover the language problems of science students:

1. Securing by questionnaire and interview the opinions of many high school students.

2. Securing by questionnaire and interview the opinions of seventeen high school science teachers.

3. Securing by questionnaire and correspondence the opinions of twenty high school teachers of English.

4. Examination of handbooks and manuals of communication in current use by the United States Air Force, the United States Army, the Martin Company, the General Electric Company, and others.

5. Examination of earlier studies made in the field of language problems in science education.

6. Visit to the Weld County Science Fair, March 6, 1959, to examine communication methods.

Many interesting conclusions could be drawn from the data secured for this study; a few of them follow.

Science teachers and students recognize the existence of language problems in learning science, but they do not agree on the relative importance of these problems.

All three groups of students gave high priority to the *ability to report orally* and to the problem of *organizing ideas into a logical form.*

Science teachers agreed that the main problem faced by their students was the *ability to read with comprehension.* They ranked *vocabulary difficulties* second.

Remarkable agreement occurred between the responses of the Geneseo group and the College High School group in Greeley, but the members of the Summer Science Institute differed noticeably. The opinions of the first two groups gave identical rankings to five of the nine language factors listed on the questionnaire, while the Institute group failed to agree with the other two on any one of the nine factors.

Superior science students admit having language difficulties, and their English teachers verify this fact by personal letters to the author. *Spelling, sentence structure, and oral expression* were mentioned most frequently by the English teachers.

The Summer Science group alone gave high ranking to the *ability to write good, clear sentences.* The other two groups, oddly enough, ranked this factor as either last or next to last in importance to their success in studying science.

TABLE I

Importance of Language Factors in Studying Science (Comparison of Rankings by Groups)

Group	First	Second	Third	Fourth	Fifth
Teachers	Ability to read and comprehend	Vocabulary	Ability to organize ideas logically	Ability to locate references in library ←tie→	Ability to read and comprehend current science material
Geneseo High School Students	Vocabulary	Ability to report ideas orally	Ability to read and comprehend	Ability to read and comprehend current science material	Spell correctly
College High School Science Students	Ability to organize ideas logically	Ability to report ideas orally	Ability to read and comprehend current science material ←tie→	Vocabulary	Spell correctly
Summer Science Institute Students	Spell correctly ←tie→	Ability to write good, clear sentences	Ability to organize ideas logically	Ability to report ideas orally	Ability to locate references in library and Ability to take notes

Total: 19 schools

Implications of the Study

Successful achievement in scientific areas of learning is dependent upon mastery, or at least the improvement, of communication skills. Although the opinions of students and teachers vary considerably, they all seemed to agree that there is a definite need for improvement in written and oral expression. The science teacher, notwithstanding his increased responsibility for keeping pace with a rapidly expanding frontier of knowledge, may also have to accept a greater share of the burden of teaching language skills. The English teacher, on the other hand, may do well to work more closely with his colleague in science to effect a cooperative attack upon the problems of communication. The Summer Science Institute of Colorado State College and similar institutes provide excellent opportunities for teachers in different fields to work together to find the answers to many of these problems.

VOCABULARY

Basic Factor for Understanding Science

By NEIL E. WEST

Teaching Assistant, Oregon State College, Corvallis, Oregon

IN any content field dependent upon written language for communication, reading is an essential skill in learning. Proficiency in reading is extremely important for mastery of the sciences. But the sciences employ a specific language and specific skills. Thus, general reading ability, frequently applied as an indicator of success in reading, cannot be weighed as heavily in determining successful science reading.[1]

One of the primary methods to speed up science teaching is to have the students acquire a vocabulary of scientific terms. By considering the relationships of vocabulary to the problems and shortcomings of science reading, we may be able to help our students attain the comprehension which they need for a strong background in science.

Contributing Factors

Many educators see vocabulary as one of the primary causes of difficulties encountered by the student in science reading. Novak states that: "The vocabulary of science is more extensively specialized and exact than is the language common to any other content field." [2] The task of teaching science would be more successful, therefore, if the student has mastered the vocabulary of his subject material.

Vocabulary is closely associated with the learning process of science, a "building block" method with the "blocks" as the words and the concepts they represent. Scientific words are so specific and condensed that unless they are explained and understood by the students, effective learning will not be achieved. Each concept must also be developed, and this presumes an understanding of the terms involved. Unless an examination requires the student to do more than transfer the word from the textbook definition or example, he will merely parrot the given definition of the word. It cannot be assumed that he will have a command of the underlying concept or its application.

The demands of an exact terminology decidedly limit the connotations which can be applied to scientific words and the meanings which can be derived from context. With the exception of mathematical terms, vocabulary from others fields cannot be transferred as readily to aid scientific reading. To the older scientific terms must be added the new terms which describe expanded and updated research. Again, exact definitions are required. Because use of new terms is relatively infrequent in popular literature, our total vocabulary problem increases.

The rote memorization necessary to learn the primary terms of an introductory science can easily lead to student verbalization. By noting the following definition from a high school physics textbook, one can see why memorization would never result in real learning. "One farad is the capacitance of a conductor in which one coulomb may be put with the potential difference of one volt." [3]

Confusion also results from the usage of scientific terms in everyday life and in the science class. Consider the relative meanings of the words "work," "flower," and "cell," as used generally and as used scientifically. It is easy to understand how the word shifts can be misleading. Newspapers and other periodicals contribute to this difficulty by their broad usage of scientific terms without discretion.

Pronunciation difficulties seem to be highly correlated with undeveloped meanings, and both failings are prevalent among students. Sentence structure demands exact definitions, for the meaning of the whole sentence usually

[1] National Society for the Study of Education, Forty-seventh Yearbook, Part II. *Reading in the High School and College*. The University of Chicago Press, Chicago, Illinois. 1948. p. 162.

[2] B. J. Novak. "Reading Problems in Science." *Education*, 68:625. June 1948.

[3] William Scott Gray. *Improving Reading in the Content Fields*. The University of Chicago Press, Chicago, Illinois. 1947. p. 105.

is dependent on the explicit meaning of one scientific term.

Spelling problems in science subjects occur frequently and are connected with the accompanying difficulties of pronunciation, recognition, and meaning. The positive correlations between these factors tend to compound the problems involved and act as a deterrent to progress in reading.[4]

Vocabulary in Textbooks

Since the majority of the vocabulary new to the science student is first encountered in his textbook, we are expected to treat many of the vocabulary problems associated with the material he reads from his textbook. Through numerous studies on the vocabulary frequency and difficulty of words in science texts, authorities have agreed that science textbooks, in general, overuse technical vocabulary and scientific descriptions. Many teachers feel that they are too difficult for the average high school student, because of the appeal to a more advanced group of adults, as well as teachers.

A considerable number of rare words, not encountered in general adult reading, are included in our basic high school textbooks. A high school class of first-year foreign language students acquires a vocabulary of 800 to 1000 words, while a high school science student learns an equal or greater number of scientific terms plus all of the associated and applied concepts covered in that course.[5] In one commonly used high school physics book, three chapters contain more than 100 words of a technical nature. A group of college graduates tested knew the meaning of slightly more than one-half of the terms listed in this textbook.[6]

Textbook difficulties are usually measured by word frequency, and the levels are determined by the use of such lists as Thorndike's compilation of the most common 10,000 words widely used as a "yardstick" to measure relative difficulty. The words not included in this list are considered to be unfamiliar to the average ninth-grade student. High school students of average ability generally begin to lose comprehension at the 7000-word level.[7] Most of the words causing difficulty lie between the 10,000- and 20,000-word levels, indicating that the authors of the textbooks have made some attempt to limit the difficulty of the vocabulary. A considerable share of these unfamiliar words, however, are of the nontechnical nature and could easily be eliminated to reduce the over-all difficulty a student encounters in reading. Easier synonyms could undoubtedly be substituted in texts which are now overburdened with difficult and infrequently used words of a nontechnical nature.

High school chemistry texts contain the largest vocabulary of technical words, with physics, biology, and general science following in that order.[8] In general, the vocabulary level of high school students appears to have been overestimated by the majority of textbook authors.

Many terms associated with reading difficulty are not used frequently enough in the textbook for the student to gain familiarity with and grasp meaning from the words. Furthermore, definitions of newly introduced words instead of standing in close proximity often follow in a later paragraph. Thus the student glances at the unknown term without consulting the definition. In addition, glossaries of texts examined in several studies were found to be quite meager in relation to the number of terms introduced.

We need, therefore, to improve the vocabulary of science textbooks and to make learning easier and of more value to our students. In preparing instructional materials, we can certainly profit from the findings of educational research.

Advantages

One advantage in learning the vocabulary of science is that once the concepts are learned, one can communicate more precisely to others who understand the subject. A more common meaning exists between the conversants because of the restrictions of meaning which reduce the connotations of the words used.

Many of the scientific words are composites of other words learned at lower grade levels. Greek and Latin roots, suffixes, and prefixes are readily transferable to the science vocabulary. In fact, explanations of etymologies may be helpful in transmitting concepts to students.

Students with backgrounds in algebra, trigonometry, and geometry have a distinct advantage in studying the physical sciences because of the close association of many mathematical terms with this area of science.

Every teacher should be considered as a teacher of reading. Science teachers should not overlook the demands of effective communication in their field as well as in everyday life, and so should stress correct spelling and grammatical construction in their classes.

A variety of textbooks with differing levels of vocabulary difficulty can be used effectively within one class to provide for a wide range of individual reading abilities. The less able student may be aided by a textbook of less difficult vocabulary content written for a lower grade level.

Conclusion

Recalling the analysis of vocabulary in relation to reading in the sciences, we should align our perspectives with the objectives of our teaching programs. We should strive to assist our students in making words and their associated concepts become permanent possessions, used every day. We should also remember that students must be able to understand the subject material, enjoy it, and see its usefulness before they will find their efforts rewarding.

It is highly possible that many students do not elect science courses in their high school programs because of the technical language they encountered in their required science courses. Probably for the same reason, many people do not include science topics in their recreational reading. The importance of interest in developing reading skills can hardly be overemphasized. Most of use will agree with Doran that, "The one who has a vague, ill-defined knowledge of words has vague, ill-defined thoughts and is incapable of definite, systematic, and logical thinking." [9] Science teachers will also probably adhere to the aim that science should be taught for the method of thinking involved. From these two ideals we may conclude that true learning of science is fundamentally centered around the mastery of the vocabulary concerned.

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[4] Novak, *loc. cit.*, p. 627.

[5] Lillian Gray. "Making It Their Own." *NEA Journal*, 40:405. September 1951.

[6] William Scott Gray, *op. cit.*, p. 105.

[7] *Ibid.*, p. 57.

[8] Novak, *loc. cit.*

[9] H. L. J. Carter. "Reading, Contributing and Concomitant Factor in the Study of Science." *School Science and Mathematics*, 54:567. October 1954.

SERIES II:

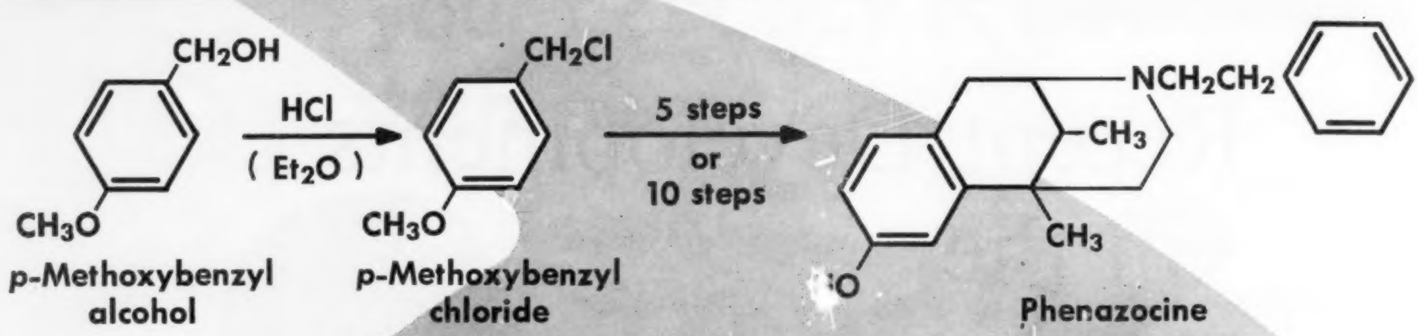
Recent Developments in the Life Sciences

A Series of Experiments, Demonstrations, and New Ideas

Part B: Metabolic Diseases Research

THE reports which follow conclude those begun in the October issue of TST of the Second Science Demonstration Conference. Sponsored jointly by the National Institute of Arthritis and Metabolic Diseases and the National Cancer Institute, the conference was held early last fall for high school teachers in Washington, D. C. and the surrounding area. The first conference took place in 1955 and has been reported as Series I in the March, April, and May issues of *The Science Teacher*, Volume 23, 1956.

Science teachers check in at the registration desk. They were among a total of more than 200 which attended the conference.



Man Against Pain

By HUGH JACKSON

Information Office, U. S. National Institute of Arthritis and Metabolic Diseases

THE will to live and to avoid being hurt are strong instinctive urges in man. Consequently, one of his major objectives throughout the course of history has been the conquest of pain. As it is with death and taxes, complete avoidance or suppression on a permanent basis has seemed an impossible achievement. However, progress has been made. Even before the advent of recorded history, opium was found and its pain-killing and euphoric properties discovered. Dioscorides, the Greek medical author, writing in the second century recorded full directions for preparing opium from the exudate of the unripe seed capsule of the opium poppy, and the method he described has remained virtually unchanged through the centuries and up to the present day.

The latest significant chapter in the story of man's struggle toward the conquest of pain has been written by two NIH scientists, Dr. Everette L. May, a chemist, and Dr. Nathan B. Eddy, a pharmacologist, of the U. S. National Institute of Arthritis and Metabolic Diseases. They developed phenazocine, a remarkable, new, synthetic-analgesic drug which, although much more powerful than morphine, is safer to use and more effective. This potent new drug is now on the market and in general use throughout the United States.

Morphine, the standard by which other potent analgesic drugs are measured, has, through the years, demonstrated its power both as a blessing and as a curse. Its ability to allay severe pain has been of great solace and service to mankind, reserving for it a very special place in every physician's bag. Yet, it has important disadvantages which have limited its usefulness. Outstanding among morphine's detriments is its ability to enslave the unwary user as an addict. Other shortcomings include such undesirable side effects as nausea, vomiting, and lowering of blood pressure.

For nearly 100 years then, ever since chemists have had some knowledge concerning the nature of morphine, they have been trying to modify it in

Dr. Everette L. May shows visiting teachers a vial containing phenazocine (NIH 7519), a new pain-killing drug ten times more potent than morphine, which he synthesized in his laboratory during 1958, in collaboration with Dr. Nathan B. Eddy.

attempts to obtain a drug which would retain the analgesic (pain-killing) potency without the several bad effects, particularly addiction liability.

Scientists working on this problem have produced numerous morphine derivatives and synthetic drugs with wide variations of pain-killing power, ranging upward from those in the comparatively low potency range of codeine to compounds much more powerful than morphine. A number of drugs in the codeine range have been developed which are very low in addiction liability, but in the high potency range of morphine, addiction potential and other harmful properties generally have increased in proportion with the pain-killing power. Phenazocine represents a significant step forward toward the ultimate goal—the complete separation of the analgesic and addicting properties of narcotic drugs. Also significant is the fact that phenazocine is a completely synthetic product made from simple and abundantly available raw materials. We are no longer dependent upon opium as a source for potent pain-killing drugs.

Experimental analgesic drugs submitted for testing are passed through a screening process by the analgesics section of NIH. Each compound is assigned a number, in sequence, as received. As an experimental drug, otherwise unnamed, phenazocine was identified as NIH 7519. It was so designated when its development was first announced by the Secretary of Health, Education, and Welfare in January 1959.

During 1959, phenazocine was thoroughly tested in laboratories, hospitals, and clinics throughout the country. These tests and trials, involving more than 3000 patients by December 1959, confirmed early expectations that in several important respects phenazocine constituted a substantial improvement over morphine and other potent analgesic drugs.

Although it must be classified as an addicting drug, phenazocine is less liable to produce and maintain physical dependence, an important aspect of addiction. This was revealed in exhaustive tests of the drug's addiction liability at the Public Health Service Hospital, Lexington, Kentucky.

On the basis of clinical experience to date, it seems clearly indicated that phenazocine presents a number of advantages over morphine and similar powerful pain-killing drugs: (1) physical dependence, one aspect of addiction liability, develops more slowly and is less intense; (2) the drug is more powerful and may relieve pain that morphine, in optimal doses, does not; (3) it has fewer and milder side effects in clinical use, an advantage which makes it effective in cases, such as labor pain, where morphine would be contraindicated; (4) in cases of chronic pain, such as cancer, it can be used more safely over longer periods of time; and (5) because it is more potent, phenazocine achieves its pain-killing effect at a fraction of the dosage level necessary with morphine.

Important points to remember about phenazocine and its use:

(1) Although it may be, in some respects, less addicting than morphine, phenazocine *is* an addicting narcotic drug, available only upon a qualified physician's prescription.

(2) Phenazocine is not and will not be available in drug stores as an over-the-counter item; it is available at the present time only in liquid form, for injection, and should be administered only by a physician or under his direct supervision for the treatment of conditions involving severe pain. Indications and precautions concerning its use are much the same as for morphine.

(3) Phenazocine is not specifically indicated in the treatment of arthritis. It is not an antirheumatic drug, and only rarely might a physician find it advisable, in an extreme case, to use it in the treatment of arthritic pain.

Six pharmaceutical companies have been licensed by the Department of Health, Education, and Welfare to manufacture, distribute, and use phenazocine in the United States, subject to all applicable laws, rules, and regulations governing the manufacture, sale, and use of narcotic drugs. Of these companies only one, Smith, Kline and French Laboratories, Philadelphia, Pennsylvania, has been authorized by the Food and Drug Administration to market its brand of phenazocine, under the trade name Prinadol. Other licensees have not as yet applied for authorization. As an act of good will, the United States has made phenazocine's formula and method of synthesis available without restriction to other countries throughout the world. Drs. May and Eddy, in whose names phenazocine is patented, have surrendered all their rights, domestic and foreign, to the United States government.

In conclusion, it should be noted that although phenazocine emerged successfully from many months of tests and investigations and is now on the market for general use in the fight against pain, it is not by any means the end of the search for new and better analgesic drugs. It is merely a new beginning for a program of basic research that has contributed, over the course of thirty years, increasingly significant findings. The National Institutes of Health is not in the business of drug development. Basic research, which aims to create new knowledge, whether it pertains to an immediate problem or not, develops from time to time practical and immediately applicable findings. Phenazocine was one of these, and there may be more. Phenazocine itself, of course, can be improved upon. It is only one of a completely new family of compounds, the benzomorphan series, whose discovery by Drs. May and Eddy has opened up a new pathway of analgesic research which has tremendous potential.

As a matter of fact, it is possible that some of this potential may be realized in the near future, for Drs. May and Eddy have in the process of screening, several new and promising benzomorphan compounds, cousins of phenazocine, which, with pain-killing potency approximating that of morphine, have demonstrated in preliminary screening tests a lower addiction potential than either morphine or phenazocine. It is

Dr. Nathan B. Eddy has spent more than thirty years in research seeking substitutes for the addicting pain killer, morphine.

entirely possible that another NIH-number analgesic may become well-known—for example: NIH 7569.

Pain-Relieving Potency of Analgesic Drugs

An idea of the relative pain-killing power of analgesic drugs may be obtained by rating them on the basis of equivalent doses, on a numerical scale, assigning to morphine the value of 100. At the top of the list are phenazocine (NIH 7519) and 14-hydroxydihydromorphinone (Numorphan), a morphine derivative. At the bottom of the list is aspirin which actually does not belong with the other drugs listed, but is inserted for comparison.

500-1000	Phenazocine (NIH 7519), 14-hydroxydihydromorphinone (Numorphan)
500	Levorphanol (Dromoran)
300-400	Dihydromorphinone (Dilaudid), Metopon
300	Heroin
100	Morphine, Methadone (Dolophine)
80-90	Dihydrohydroxycodeinone (Eucodal)
30-50	Anileridine (Leritine), Diethylthiambutene (Themalon)
20-30	Meperidine (Demerol)
15	Codeine
1-2	Aspirin

The medical usefulness of each of these drugs varies not so much with regard to its potency as with other characteristics. For an ordinary headache or muscular pain aspirin might well be sufficient. For moderate pain, codeine might be called for; but for severe pain, one of the more potent drugs would have to be used. For each drug there is an "optimal dose," beyond which additional pain relief either cannot be obtained or can less safely be obtained. Thus, it is not possible to relieve some forms of pain with codeine, no matter how large a dose might be given, while, on the other hand, codeine might easily relieve pain aspirin does not touch. In some cases a drug may provide pain relief, but only in such a large dosage that dangerous side effects might follow.

All of the drugs listed are addicting to some degree, with the exception of aspirin, which definitely is not. Heroin, although listed above, is not used in medical practice in the United States. It is an illegal drug which cannot be imported or manufactured in this country. It has been banned because of its high rate of abuse as an addicting drug.

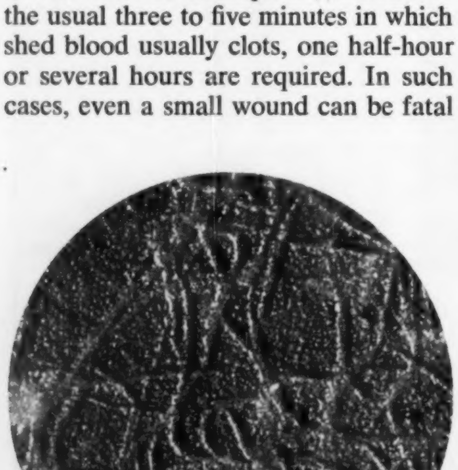
The Clotting of Fibrinogen

An Example of Enzyme Action and of Gelation Through Polymerization

By KOLOMAN LAKI

Laboratory of Physical Biology, U. S. National Institute of Arthritis and Metabolic Diseases

Principles: The clotting of blood is a familiar phenomenon to everybody. It is a defense act of the body to prevent fatal loss of blood. If clotting does not function properly, or if clotting is delayed, a serious situation may arise. In the case of hemophilia, instead of the usual three to five minutes in which shed blood usually clots, one half-hour or several hours are required. In such cases, even a small wound can be fatal if no medical help is given (blood transfusion). On the other hand, if blood is too eager to clot, a clot may be formed in the blood vessels. Should this happen repeatedly, serious situations arise (*e.g.,* thrombosis).

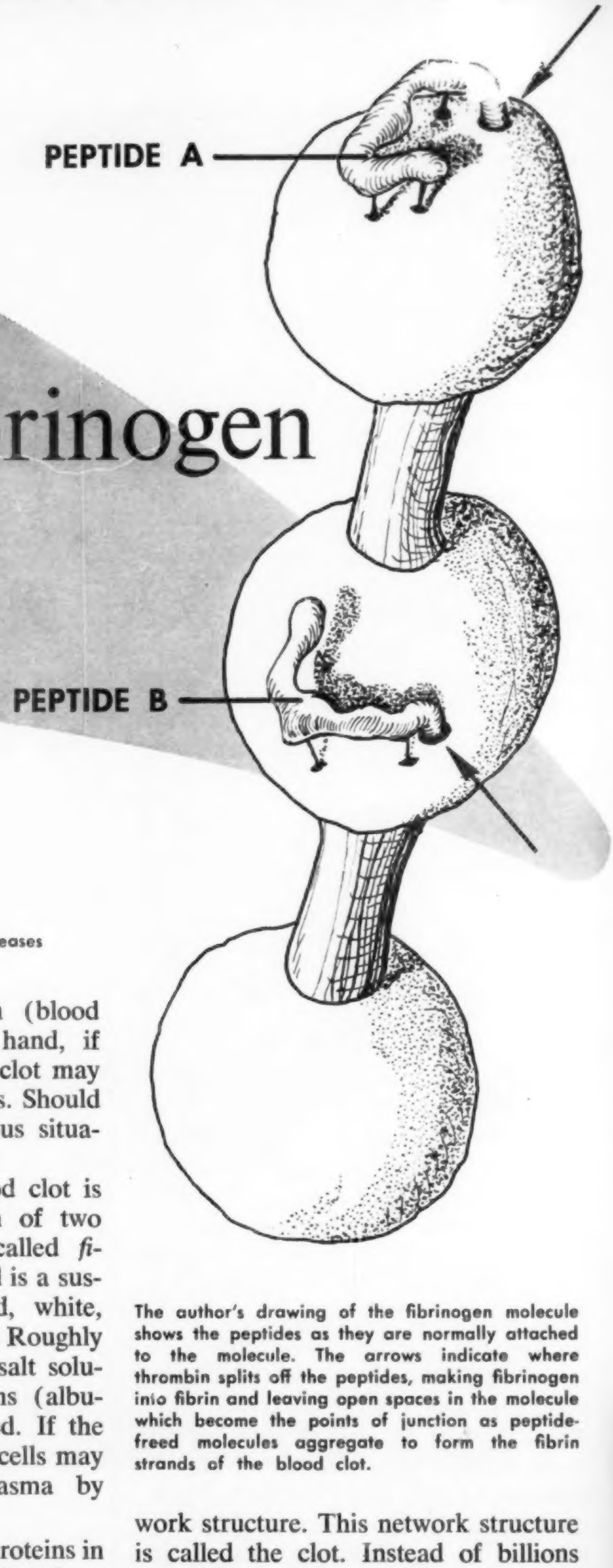


An electronmicrograph of clotted blood shows the crevice-like outlines of strands of fibrin molecules. The higher portions of the micrograph are fluid spaces.

The formation of the blood clot is the result of the interaction of two blood *plasma* components called *fibrinogen* and *thrombin.* Blood is a suspension of blood cells (red, white, platelets) in the blood plasma. Roughly speaking, blood plasma is a salt solution in which various proteins (albumins, globulins) are dissolved. If the blood is carefully drawn, the cells may be separated from the plasma by centrifugation.

There are about 70 mg of proteins in one ml of plasma (plasma is, therefore, a 7 per cent protein solution). Out of these 70 mg of proteins, 4 mg is a special protein called fibrinogen.

When blood comes into contact with the surface of the wound, a minute plasma component called prothrombin becomes converted into thrombin. This thrombin attacks the fibrinogen molecules one by one, cutting off a small part of them. Attacked fibrinogen molecules quickly aggregate into a net-



The author's drawing of the fibrinogen molecule shows the peptides as they are normally attached to the molecule. The arrows indicate where thrombin splits off the peptides, making fibrinogen into fibrin and leaving open spaces in the molecule which become the points of junction as peptide-freed molecules aggregate to form the fibrin strands of the blood clot.

work structure. This network structure is called the clot. Instead of billions and billions of the little molecules, we now have the clot which could be looked upon as a visible, huge molecule. The clot is a plug which closes the wound and prevents loss of blood.

Thrombin in this "clotting process" acts as a "catalyst"; it is not consumed in the process. Catalysts of biological origin are called *enzymes.* The role is to split off 3 per cent of the fibrinogen molecules. The so-altered fibrinogen molecules then join up (polymerize) to

make the network. In this part of the process, thrombin has no role at all. Study of the material split off revealed a mixture of two peptides containing about twenty amino acids. Both *fibrinogen* and *thrombin* can be separated out from blood plasma and used in purified form for experimentation.

To obtain fibrinogen from blood plasma is comparatively simple, but to obtain thrombin requires more elaborate procedures. If we add a quantity of saturated ammonium sulfate solution equal to one-third of the volume of the plasma, fibrinogen will precipitate. This precipitate can be removed (*e.g.*, by centrifugation), redissolved in dilute salt solution, and studied. The *purpose* of this demonstration is to show some experimentation with *thrombin* and *fibrinogen*.

Materials

Glassware:

a. Test tubes, about 15 cm long and 11 to 15 mm wide.
b. Pipettes, 1-ml, 0.2-ml (with 0.01-ml graduation), 10-ml, 1 capacity.
c. Erlenmeyer flasks, 400 to 500-ml capacity.
d. Beakers, 400 to 500-ml capacity.
e. Test-tube holders (racks).
f. Stopwatch.
g. Graduated cylinder, 200-ml capacity.

Spatula.
Fast-draining filter paper.
Graph paper.
Chemicals:

KH_2PO_4
Na_2HPO_4
HCl
$(NH_3)_2SO_4$
Fibrinogen
Thrombin

Fibrinogen Solution

Weigh 1.36 g of KH_2PO_4 (Mol W 136.09) and 1.9 g of $Na_2HPO_4 \cdot 12 H_2O$ (Mol W 358.17). Put them into a beaker (400 ml), and add 200 ml of distilled water to it. Stir gently until the salts dissolve. To the solution add 4 g of fibrinogen powder (bovine fibrinogen, Armour Laboratories). Stir gently to avoid foaming until most of it dissolves (a few undissolved particles may remain). Pour the solution into a 500-ml Erlenmeyer flask; add 200 ml of distilled water to the solution. Finally, add ten drops of HCl solution while gently stirring. (The pH of the solution is about 6.5.) Let it stand in the refrigerator overnight or at least a few hours, and then filter through fluted filter paper (any fast-draining filter paper will do) to remove precipitate. A clear solution is obtained. This solution is now ready for use and should be kept in the cold when stored.

Thrombin Solution

Open up one bottle containing dry bovine thrombin powder (Parke-Davis, Thrombin Topical 5000 U of thrombin per vial). Add 5 ml of distilled water to it to dissolve the powder. This is the stock thrombin solution. In one test tube make up a dilution the following way: to 0.2 ml of stock solution add 1.8 ml of distilled water.

Using a test tube, Dr. Koloman Laki explains the manner in which blood clots are formed.

Dr. Koloman Laki demonstrates steps in the process of blood clotting, explaining the stages by which prothrombin becomes thrombin which, in turn, acts upon fibrinogen in flask to form clot.

Procedures are given below for the clotting of fibrinogen by thrombin.

Part I: Mark one test tube so that it will serve as a measuring flask for 10 ml of fibrinogen. Then number six test tubes from 1 to 6.

Add 0.025 ml of the diluted thrombin solution into Test Tube No. 1, then measure out 10 ml of the fibrinogen solution. Now, pour this quickly into Tube No. 1 which you hold in the left hand. Immediately, cover up the opening of this test tube, turn it over quickly for mixing, and in the meantime start a stopwatch. Place a piece of newspaper behind the tube and watch a selected letter until you cannot recognize it. As the clotting proceeds, the solution becomes more and more turbid; arrest the stopwatch when you cannot recognize the letter any more (because the turbid solution obscures it).

In my experiments it took one minute and twelve seconds to lose a selected letter from sight. (Place Tube No. 1 back into the rack because we are saving these clots.) Now take Tube No. 2, add 0.05 ml of the thrombin solution to it. Again measure out 10 ml of fibrinogen. Pour it onto the thrombin. Turn it over, start stopwatch, and proceed as previously. This time you probably measure 40 to 38 seconds; save the clot again. You proceed simi-

larly with the rest of the tubes using thrombin solutions of varying amounts.

As you increase the thrombin concentration, the "clotting time" (time taken from the start of the reaction until you cannot recognize the letter in the newspaper) decreases.

By the time the letter of the text becomes unrecognizable, about half or three-fourths (depending on how you judge it) of the fibrinogen has joined up to make the network. So the clotting time measures the time necessary to have the reaction half completed. As you increase the amount of thrombin, this time becomes shorter and shorter. The reciprocal of the clotting time is related to the "velocity constant" of the reaction. When you plot these reciprocal clotting times (multiplied by 100 for sake of convenience), you can see that as you increase the thrombin concentration, the velocity of the reaction increases (though not linearly).

One can repeat the experiment several times at a given thrombin concentration and calculate the average clotting time and its error (standard deviation).

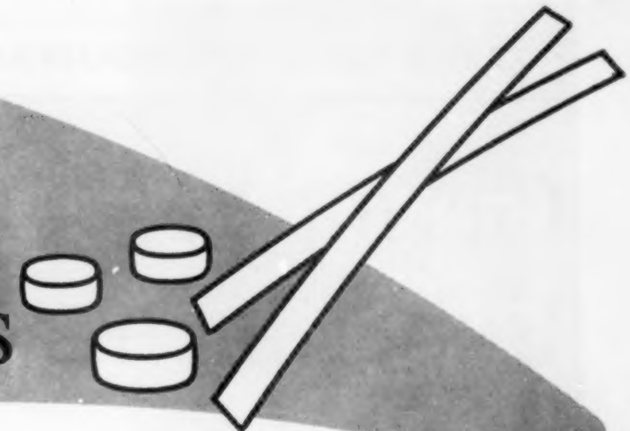
The experimenter, of course, can make different thrombin dilutions and measure longer and shorter clotting times. Above two minutes and below 13 to 14 seconds, however, the readings are not very accurate.

Part II: All the test tubes containing the clot are now collected and by rolling up the clot on a flat spatula, each of the clots can be separated from the fluid. Simply by inspection, it is evident that these clots are identical in weight. Although there was about tenfold variation in the thrombin concentration, there is no variation in the amount of clot formed. This is a clear demonstration that thrombin acts as an enzyme and does not become part of the clot and that very small amounts of thrombin are enough to convert fibrinogen. The clot is exclusively the network of the "thrombin-altered" fibrinogen molecules. As a matter of fact, another 10 ml of fibrinogen may be added to the fluid after clot removal. Then observe that it too will clot, showing that thrombin is still in the fluid and did not become part of the clot.

The removed clots can be washed first in 70° C tap water for a few minutes, then in cold distilled water. After they are dried, their weight may be measured.

PART B: METABOLIC DISEASES RESEARCH

Use of Commercial Diagnostic Reagents



By SIDNEY S. CHERNICK

Laboratory of Nutrition and Endocrinology, U. S. National Institute of Arthritis and Metabolic Diseases

ONE important limitation on the laboratory exercises performed by students is the length of time necessary for even simple quantitative analyses in biochemical experiments. Unless samples are to be stored until the next session of the class, chemical analyses must be simple and quick. It is the purpose of this demonstration to acquaint you with some of the new rapid methods of analysis available commercially as clinical diagnostic aids. The primary advantage of these "pill and strip" methods is speed, but some are quantitative enough for classroom work. From the many tests available, I have selected two that measure glucose and one that measures protein for demonstrating the kind of laboratory exercises the enterprising teacher and student may devise.

1. *Glucose utilization by yeast:* 10 g of fresh baker's yeast dispersed in one liter of 0.1 M phosphate buffer, pH 7.0 (5.42 g of NaH_2PO_4 and 21.87 g of $Na_2HPO_4 \cdot 12\ H_2O$). Each student group is given 100 ml of this suspension. To 20 ml aliquots of suspension add 5 ml of 5 percent glucose solution; place one in the cold and the other in a 40° C water bath. Aerate with house air line or oxygen cylinder. Measure fall in glucose concentration by testing five drops with Clinitest reagent tablets and compare against glucose standards (0.25, 0.5, 0.75, 1.0 per cent).

The intense interest of a teacher participant is caught as Dr. Sidney S. Chernick lectures on the use of commercial diagnostic reagents.

Variations

Different groups of students may use different sugars such as lactose, mannose, fructose, galactose, pentoses, etc. The effect of pH, various ions, and inhibitors may be tested. The respiratory gas CO_2 may be collected in $Ba(OH)_2$ and the $BaCO_3$ weighed or titrated.

2. *Invertase in yeast:* To five ml of one per cent sucrose solution add one ml of yeast suspension. Test solution for reducing sugar (Clinitest tablets) and for free glucose (Clinitest strips or Testape) before addition of yeast and at five-minute intervals thereafter. Note effects of temperature, pH, etc. Test effect of boiled yeast suspension.

Invertase occurs in the juices of the small intestine and accounts for the rapid absorption and utilization of sucrose: Sucrose $\rightarrow$ glucose $+$ fructose. Check the reaction with other disaccharides, such as maltose and lactose, or polysaccharides, such as inulin and starch.

3. *Protein digestion:* Prepare a protein solution (0.3 per cent serum albumin, outdated plasma, or gelatin in water). The solution should be neutral or slightly basic. Prepare a dilute solution of proteolytic enzyme (pancreatin, papain—a meat tenderizer—etc.) such that it produces a negative or trace test for protein. The protein-test reagent may be Albutest tablets or Albustix.

Incubate a small quantity of the protein solution with various amounts of the proteolytic solution, and test for digestion of protein with test reagents. Observe the effects of pH, temperature, and concentration of proteolytic enzyme. The disappearance of protein is indicated by the reduction in the intensity of the protein test.

Materials

The following diagnostic reagent tablets and paper strips are obtainable from your local pharmaceutical suppliers.

Glucose:	Clinitest strips (Ames)
(Enzymatic)	Testape (Lilly)
Reducing sugars:	Clinitest tablets (Ames)
(Copper reduction)	Dextrotest tablets (Ames)
Acetone:	Acetest tablets (Ames)
	Ketostix strips (Ames)
Protein:	Albutest tablets (Ames)
	Bumintest tablets (Ames)
	Albustix strips (Ames)

Additional information may be obtained from Ames Company, Inc., Elkhart, Indiana, Eli Lilly and Company, Indianapolis, Indiana, and from your local pharmaceutical detail men and suppliers.

PART B: METABOLIC DISEASES RESEARCH

Germfree Experiments

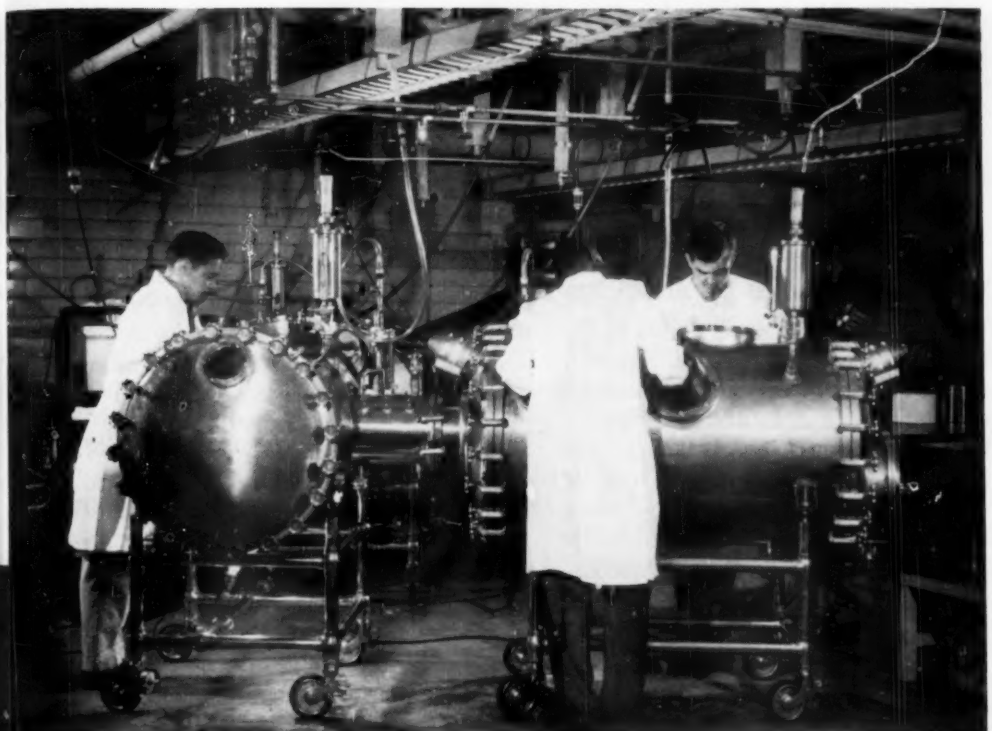
GERMFREE animals have become a valuable new tool for nutrition research at the National Institute of Arthritis and Metabolic Diseases, where they are helping to explain the role played by intestinal bacteria in the nutrition and metabolism of the host. The animals must be reared and maintained in an environment that is completely free of bacteria. They are kept in metal or plastic tanks that are air-tight and sterilizable, and all incoming air, food, water, and equipment are made sterile before entry. All handling of the germfree animals is done through long rubber gloves which are sealed to the sides of stainless steel tanks.

Stainless steel, germfree tank with protruding rubber gloves which provide aseptic access to the experimental animals living inside fills foreground in this view of the germfree laboratory. Dr. Bengt Gustafsson (in white coat) answers questions by visiting high school science teachers.

Special translucent, plastic, germfree enclosures have been developed to house mono-contaminated rats. These germfree animals have been deliberately contaminated with a single pure strain microorganism so that its effect on the host animal can be studied.

Caesarean section is performed close to the time of the expected spontaneous delivery of a pregnant, conventional animal. The umbilical cords of the baby guinea pigs are clamped with hemostats.

Caesarean delivery of guinea pigs is accomplished through a thin plastic membrane which adheres to the mother's abdomen and separates her from the germfree environment of the tank. The incision is made with a cautery knife.



Germfree animals are obtained by Caesarean operation in the tank on the right and then transferred to the rearing tank on the left. The animals may also be obtained by transfer from other germfree enclosures or by natural birth within the germfree environment.

All food and supplies going into the tank pass through an autoclave for steam sterilization. The technician is preparing to sterilize food which has been packed into rolls for convenient handling.

A routine procedure is the daily weighing of the animals. This enables the investigators to follow the growth and gives an indication of the nutritional state.

Detection of Radio Waves From the Sun

By WALLACE A. HILTON
Head, Department of Physics

and ROGER C. CRAWFORD
Associate Professor of Physics, William Jewell College, Liberty, Missouri

RADIO waves from the sun were not observed until World War II, when in February 1942, British radar was jammed by a source of noise apparently coming from the direction of the sun. Hey interpreted this as radio emission from the sun.[1] Since that time an increasing amount of information has been obtained concerning the relationship of sunspot activity and radio emissions. Presented here is a method of detection of three types of radio emissions using rather inexpensive equipment.

An elementary and inexpensive 108-mc interferometer, which was originally constructed for the detection of the signal from the Vanguard satellites, has proved satisfactory for the detection of radio emissions from the sun.[2]

The apparatus includes two multibeam antennas, one of which is shown in Figure 1. Each antenna points in the direction of the sun at midday. The geometrical centers of the two antennas lie on an east-west line and are spaced 134.5 feet apart. The spacing was limited by the length of the roof of the building upon which they were mounted. These antennas feed to a 108-mc converter and then to a communications receiver and to a strip chart recorder. This part of the equipment is shown in Figure 2.

Since the apparent angular motion of the sun is approximately 15 degrees per hour, the signals received by the two antennas will interfere at intervals of 15.5 minutes. Thus with the sun in the field of the antennas from about 10:00 a.m. until 2:30 p.m., approximately 18 null points should be recorded during the passage of an active sun.

[1] J. S. Hey. "Solar Radiation in the 4-6 Meter Radio Wavelength Bands." *Nature*, 157:47. January 12, 1946.

[2] W. A. Hilton and R. C. Crawford. "Minimum Satellite Detection Equipment." *American Journal of Physics*, 26:371. September 1958.

FIGURE 1.
Radio emissions are picked up by apparatus using two multibeam antennas.

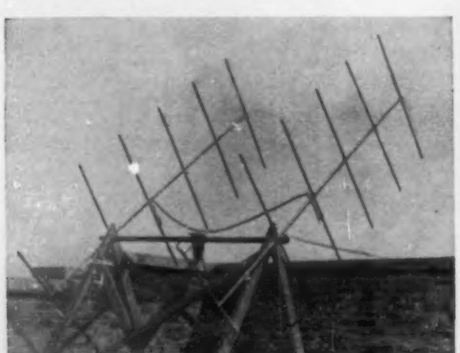
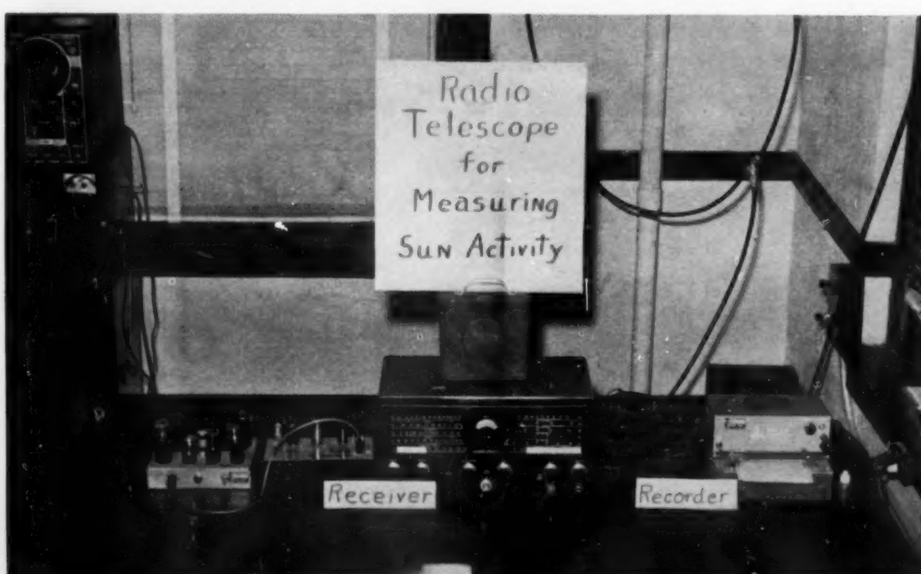


FIGURE 2. Receiver and recorder of the radio interferometer.



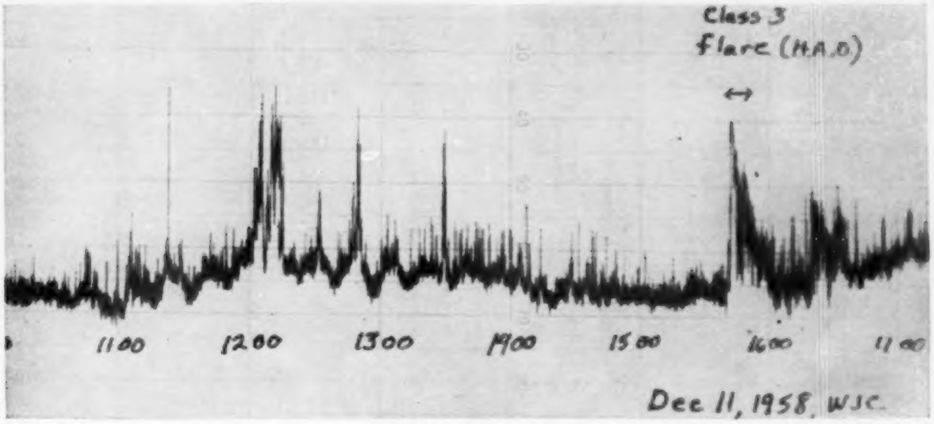


FIGURE 3. Chart recorder shows pattern of radio waves (outbursts) associated with solar flares.

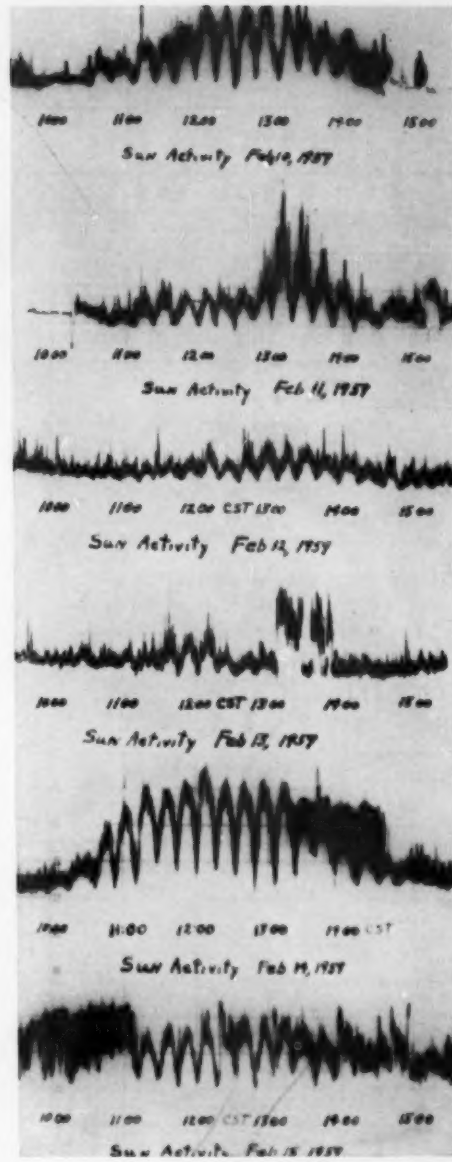


FIGURE 6.
Recording of noise storm lasting five days.

Types of Emission

The radio waves from a sun disturbed by solar flares or sunspot activity may be classified into three divisions.[3] These are (1) outbursts which are associated with solar flares, (2) noise storms which are related to large sunspots, and (3) bursts which apparently have no optical counterpart.

A typical radio outburst consists of a very sudden increase in intensity within a few seconds. It sometimes remains high but will usually decrease to its original level in less than an hour. Figure 3 shows a radio outburst as recorded December 11, 1958, beginning at about 3:40 p.m. CST and then gradually decreasing for about 30 minutes. This was probably associated with a Class 3 flare that was observed about the same time.[4]

Noise storms differ from solar outbursts in that they may last for several hours or days. The intensity varies but usually continues at a high level. An example of a recording of a high intensity noise storm is shown in Figure 4 which is the record obtained on February 8, 1958. Figure 5 indicates that the storm became less intense on February 9, but that there were strong outbursts associated with Class 2 flares. This was followed by a geomagnetic storm and a spectacular aurora which was visible as far south as the southern United States on the evening of February 10.[5]

A recording of a noise storm that lasted from February 10 to 15, 1959 is shown in Figure 6. It may be observed that the null points occur every 15.5 minutes which is in agreement with the calculated value.

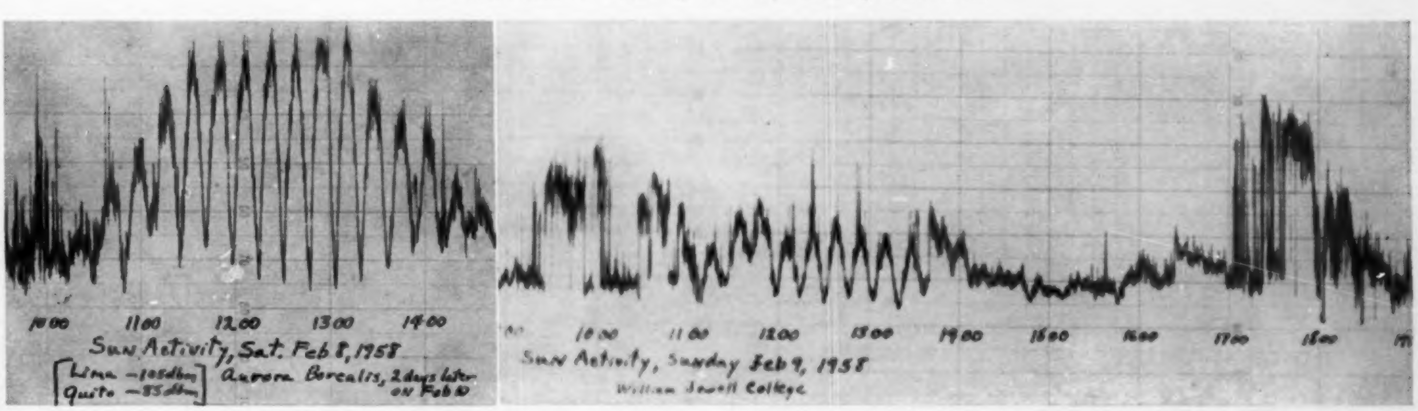
On several occasions, isolated bursts have been recorded which apparently have no relationship to visible phenomena on the sun. These seem to appear in groups, each of which may last

[3] R. H. Brown and A. C. B. Lovell. *The Exploration of Space by Radio.* John Wiley and Sons, Inc., New York. 1958. p. 121.

[4] "Preliminary Report of Solar Activity." High Altitude Observatory, Boulder, Colorado. December 12, 1958.

[5] "Preliminary Report of Solar Activity." High Altitude Observatory, Boulder, Colorado. February 14, 1958.

FIGURES 4 and 5. Recordings of a high intensity noise storm.



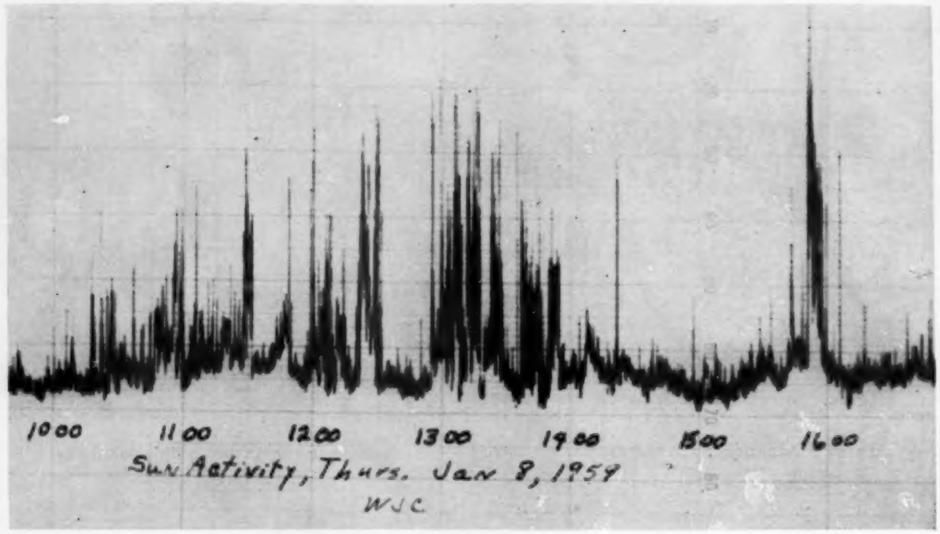


FIGURE 7. Recording of isolated bursts.

only a few seconds or less. Figure 7 is a recording of this type of sun activity made on January 8, 1959.

Summary

An inexpensive radio interferometer capable of detecting the three major types of sun activity has been constructed. Records of sun activity have been obtained, and a study has been made of the relationship of these records and the visible sun activity as reported by the High Altitude Observatory at Boulder, Colorado.

Ninth Annual Convention • Hotel Sherman

Chicago, Illinois • March 24-29, 1961

"The Science Teacher: Seeking Excellence in an Age of Science" is and intends to be a provocative theme for the Ninth Annual NSTA Convention. Everyone teaching science today is faced with an overwhelming and virtually impossible task: keeping abreast of the advances being made in even a small segment of those fields which provide basic instructional foundations for students. Add to this the local, state, and national programs of the National Science Foundation and those under the National Defense Education Act—all aimed to revolutionize the teaching of science in content and methods—and the result is a myriad of problems which must be resolved by the science teacher day by day.

The program of the 1961 Convention concentrates on "The Science Teacher" as he faces the many challenges of our times. First in perspective are the products of science. Specifically, the most recent scientific discoveries will be viewed in survey, through evaluation and indication of possible trends and imminent breakthroughs, and by noting the problems confronting the researchers in these fields. Two speakers will keynote the First General Session: **Dr. Henry C. Eyring,** Dean of the Graduate School, University of Utah, Salt Lake City, speaking on **"Recent Fundamental Discoveries in the Physical Sciences,"** and **Dr. James F. Crow,** Head of the Department of Medical Genetics, University of Wisconsin, Madison, reviewing **"Recent Fundamental Discoveries in the Biological Sciences."**

Products of teamwork in science will be presented in the Second General Session. **Dr. Hugh Odishaw,** Executive Director of the U. S. National Committee for the International Geophysical Year, National Academy of Sciences—National Research Council, Washington, D.C., will discuss the projects, accomplishments, and discoveries of the IGY program in **"International Teamwork in Science."** NSTA's role in the international sphere will be reported by **Dr. Abraham Raskin,** Professor of Physiology and Coordinator of the Sciences at Hunter College, New York City. Dr. Raskin served as director of NSTA's first international science study tour to six Western European countries last summer.

Purposes and procedures by which scientific knowledge is developed—the processes of scientific, educational, and democratic enterprise—will be detailed in the remaining general sessions, concurrent sessions, and follow-up panel discussions. Complete information on the panels and discussions will be included in the Convention Program, issued to all NSTA members in February 1961.

"The Nature of the Scientific Enterprise"—developing the methods and aims of science and the philosophical and ethical problems inherent in our technological age—will be studied in the Third General Session. **Dr. Paul E. Klopsteg,** Chairman of the Board of Directors of the American Association for the Advancement of Science, Washington, D.C., is the speaker.

In the Fourth General Session, **Dr. Joseph J. Schwab,** Professor of Natural Sciences and Education at the University of Chicago, Chicago, Illinois, will elucidate methods by which classrooms, laboratories, curriculum, and general objectives can be organized to reflect the changes in our culture. The topic: **"The Nature of the Educational Enterprise in This Scientific Age."**

Fifth General Session speaker is **Dr. Glenn T. Seaborg,** Nobel Laureate for his work on transuranium elements and Chancellor of the University of California at Berkeley. Dr. Seaborg's presentation, to be given at the annual banquet on Monday, March 27, will pinpoint **"The Science Teacher as an Agent in the Educational Enterprise"** emphasizing the teacher's responsibilities, problems, training, professional standards, community status, and achievements.

"Education for Our Democratic Enterprise" will be the subject of the Sixth and final General Session. Presented by **Dr. James E. Russell,** Secretary of the Educational Policies Commission of the National Education Association and the American Association of School Administrators, Washington, D.C., this address will report on the impact of science and science education on the life of the people of our nation.

Special programs have been planned also by two NSTA Sections. The National Science Supervisors Association (NSSA) will meet Friday, March 24 and Saturday morning, March 25. The Association for the Education of Teachers in Science (AETS) will convene Tuesday afternoon, March 28 and conclude their meetings by noon on Wednesday, March 29. See the "Program at a Glance" for more details.

PROGRAM AT A GLANCE

	Morning		Afternoon and Evening	
FRIDAY March 24	8:00	Set up Exhibits	12:30	Supervisors' Luncheon. Dr. R. Will Burnett, University of Illinois, speaker
	8:30	Registration	2:00	Panel Discussions
		Sessions of the National Science Supervisors Association (NSSA)		
	9:00	**First Session:** *"Role of the Science Supervisor,"* Dr. J. C. Wright, American Association of School Administrators, NEA		
	10:00	**Individual Presentations:** *"The Important Functions of the Science Supervisor"*		
SATURDAY March 25	8:00	Registration	1:00	"Here's How I Do It" Sessions
	8:00	Exhibits	1:00	Parallel Sessions
	9:00	**First General Session:** *"Recent Fundamental Discoveries in the Physical Sciences,"* Dr. Henry C. Eyring, University of Utah. *"Recent Fundamental Discoveries in the Biological Sciences,"* Dr. James F. Crow, University of Wisconsin	1:00	Curriculum Consultant Service
	9:00	**Second Session (NSSA)**	3:00	Open for Committee Meetings
	11:00	Curriculum Consultant Service	3:00	Exhibits
	11:00	Exhibits	3:00	Film Showings
	11:00	Film Showings	5:30	Hospitality Hour and Buffet
	11:00	General Business Session (NSSA)	8:00	**Second General Session:** *"International Scientific Teamwork,"* Dr. Hugh Odishaw, National Academy of Sciences-National Research Council (IGY) and Dr. Abraham Raskin, Hunter College
SUNDAY March 26	7:30	Life Members' Breakfast	1:00	Curriculum Consultant Service
	8:00	Registration	2:00	**Third General Session:** *"The Nature of the Scientific Enterprise,"* Dr. Paul E. Klopsteg, American Association for the Advancement of Science
	8:00	Film Showings	4:00	**Special Feature:** Northern California Committee on Problem-Solving in Science (NCCOPSIS), Dr. John P. Harville, San Jose State College. Panel: *"Let's Teach Our Students to Be Scientific-Minded."*
	9:00	Exhibits	6:00	Open for Committee Meetings
	10:00	Parallel Sessions	8:00	**Fourth General Session:** *"The Nature of the Educational Enterprise in This Scientific Age,"* Dr. Joseph J. Schwab, University of Chicago
	12:00	Exhibits		
MONDAY March 27	8:00	Registration	12:00	Elementary Science Luncheon. Dr. Glenn O. Blough, University of Maryland, speaker
	8:00	Exhibits	12:00	Open for Committee Meetings
	8:00	Film Showings	1:00	Curriculum Consultant Service
	9:00	Curriculum Consultant Service	1:00	Exhibits
	9:30	Concurrent Panel Discussions	3:00	Parallel Sessions
			7:00	**Annual Banquet (Fifth General Session):** *"The Science Teacher as an Agent in the Educational Enterprise,"* Dr. Glenn T. Seaborg, University of California
TUESDAY March 28	8:00	Registration	12:30	B-I-E Luncheon. Dr. James B. Austin, U. S. Steel Corporation, speaker. Presentation of annual B-I Award
	8:00	Exhibits	1:30	Local Tours
	8:30	B-I Breakfast	1:30	Exhibits
	9:00	**Sixth General Session:** *"Education for Our Democratic Enterprise,"* Dr. James E. Russell, Educational Policies Commission, NEA	3:00	**First Session of the Association for the Education of Teachers in Science:** *"The Curriculum and Methods Course in Science—Purposes and Patterns"*
	10:45	Concurrent Panel Discussions	7:30	**Special Feature:** Major Science Curriculum Studies, speakers
WEDNESDAY March 29		**Sessions of the Association for the Education of Teachers in Science (AETS):** *"The Doctorate in Science Education"*		
	9:00	*"Purpose and Program of Study,"* Dr. R. Will Burnett, University of Illinois		
	10:30	*"On Preparation for Research,"* Dr. Herbert A. Smith, University of Kansas. *"On Preparation for Teacher Training and Supervision,"* Dr. George Pitluga, State University of New York		
	11:15	General Discussion		

Advance Registration & Reservation Form

Ninth NSTA Annual Convention • March 24–29, 1961 • Chicago, Illinois

All requests for advance reservations must be accompanied by payment in full as indicated below. *Make checks payable to the National Science Teachers Association and mail to NSTA, 1201 Sixteenth Street, N.W., Washington 6, D.C.*

PLEASE PRINT OR TYPE

Name ....

Address ....

City .... Zone .... State ....

Advance Convention Registration Fee—$3.00†

Meal Functions

If ordering for more than one, please indicate names of persons and functions each will attend: ....

....

....

	No. of Tickets		Total		No. of Tickets		Total
Supervisors' Luncheon	......	@ $4.00	....	Annual Banquet	......	@ $6.00	....
Hospitality Hour and Buffet	......	@ $4.00	....	B-I Breakfast *	......	@ $3.00	....
Life Members' Breakfast *	......	@ $3.00	....	B-I-E Luncheon	......	@ $4.00	....
Elementary Science Luncheon (specify meat or fish)	......	@ $4.00	....	Registration Fee †			$..........
* Members only				**Total Amount Enclosed**			$..........

Clip and Mail to NSTA

REGISTRATION INFORMATION

Pre-Convention registration by mail is strongly urged and will be accepted through March 3, 1961. **Do not mail forms and checks after this date** since processing prior to the convention cannot then be assured. Receipts will be sent promptly when advance registration and reservations, accompanied by remittance in full, are received in the NSTA headquarters office. Bring these receipts to the convention and present them at the Advance Registration Table on the Mezzanine to receive identification badge and tickets.

Registration fee is $3 for the entire convention, or $1 for daily registration to accommodate those who can come for only one or two days. **Registration is required for participation in all convention activities.** Those registering in advance, but unable to attend the convention, may receive refunds by sending their official receipts to NSTA headquarters before April 14, 1961.

In view of the large attendance expected at the convention, it would be to your advantage to make advance reservations for meal functions. With the exception of the Life Members' Breakfast and the Business-Industry Breakfast, meal functions are open to all convention participants. **Use the form above and send remittance along with your registration fee.** You will receive your tickets when you pick up your credentials at the Advance Registration Table.

CLIP AND MAIL TO THE HOTEL SHERMAN . . .

All convention activities—sessions and meals—will be held at the Hotel Sherman. The NSTA Convention Headquarters, Press Office, and all registration booths, including Advance Registration and Exhibitors' Registration booths, will be located on the Mezzanine. Rooms will be provided for NSTA committees that wish to hold a meeting during the convention. Arrangements for time and space assignments can be made now through the NSTA headquarters in Washington, D.C. To avoid conflicts with convention sessions, the following hours are suggested for committee meetings: Saturday, March 25, 3 p.m. to 5 p.m.; Sunday, 6 p.m. to 8 p.m.; and Monday, 12 p.m. to 3 p.m. Please consult the "Program at a Glance" on page 2 of this insert before requesting another time.

Room reservations can be made in advance by contacting the Hotel Sherman. Since lower rates are available for rooms accommodating two or more persons, you may wish to share your room. For your convenience, use the blank provided below and mail directly to the hotel.

Enthusiastic response from both exhibitors and convention participants in the past has demonstrated the important role which the annual Exposition of Science Teaching Materials holds for the science teacher. This year's exposition is designed to heighten your interest through an increased number of exhibits and well-scheduled viewing hours. Although exhibits will be open all day, special times have also been designated. Consult page 2.

The Hotel Sherman is the official hotel for the 1961 convention. Room reservations should be made early and sent directly to the hotel. **Do not mail to NSTA.** To reduce pressure for adequate housing, you are encouraged to share your room with other convention participants.

HOTEL SHERMAN
Randolph and Clark Streets
Chicago 1, Illinois

NATIONAL SCIENCE TEACHERS ASSOCIATION
March 24–29, 1961

PLEASE RESERVE:

Type Room .... No. Persons .... Rate ....
Single, double, twin, suite

Arrival Date .... A.M. P.M. Departure Date .... A.M. P.M.

Name ....

Address ....

City and State ....

Others who will share room ....

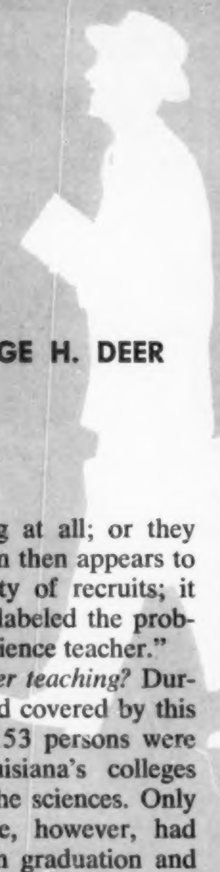
Rates

Single (1 person)	$ 7.45 - $15.95	Twin Beds	$14.45 - $22.95	Parlor-Bedroom (Alcove)	$25.50 - $28.50
Double (2 persons)	$11.45 - $19.95	Room for 3	$18.95 - $21.95	Suites (2 rooms)	$28.50 - $55.00

Two Rooms—Connecting Bath (no twin beds, 2-4 persons) .... $17.90 - $27.90

All reservations will be confirmed and guaranteed

Science Teacher? Missing?



By JOHN L. GARRETT, SAM ADAMS, and GEORGE H. DEER

Louisiana State University, Baton Rouge, Louisiana

THE scarcity of science teachers has reached the point of national concern. It is almost a paradox that the American culture, so thoroughly oriented to science and technology for its very existence, finds it difficult to maintain an adequate supply of qualified teachers in the areas of science and technology—or, for that matter, teachers in all the other areas of learning. What is the background for the shortage of science teachers? Why do not more qualified students enter the science-teacher program? It has often been assumed that those college students interested in science are attracted to industry for better salaries and simply do not enter the teacher-education program.

To test this assumption, the authors made a study of those graduates of Louisiana's colleges and universities for a ten-year period who had followed the science-teaching program in teacher education and who, upon graduation, had been certified as science teachers. The study included a survey of all college graduates in Louisiana certified to teach science from 1947, when the certification regulations were modified, to 1956. How many of these persons certified to teach science actually entered science teaching and remained? For the others, (1) why aren't they teaching? (2) would they consider entering or re-entering teaching? and (3) what is the nature of their present employment?

Results of the study lead to the conclusion that the basic problem involved is not one of attracting persons into the teacher-education program. A major facet of the problem appears to be that, after completing their preparation for teaching, a major portion of the group do not enter teaching at all; or they drop out. The problem then appears to be not one of scarcity of recruits; it might more aptly be labeled the problem of "the missing science teacher."

Did they really enter teaching? During the ten-year period covered by this study, 1947-1956, 1153 persons were graduated from Louisiana's colleges certified to teach in the sciences. Only 23 per cent of these, however, had entered teaching upon graduation and remained in it continuously. Another 11 per cent had been in and out of teaching but actually were teaching in 1956. A few others had gone into school-related jobs other than classroom teaching. About 18 per cent had entered teaching but later changed to another type of work.

But 46 per cent of the science-teaching graduates had never entered the classroom. It is this group that might be appropriately labeled "the missing science teacher." And it is this group with which the study was primarily concerned. A questionnaire was mailed to these "missing science teachers" and 739 letters were sent. Responses were received from 45 per cent.

Why did they leave or fail to enter teaching? Of those replying to this question, nearly one-third gave "lack of adequate salary" as the chief reason. "Marriage and family responsibilities" accounted for another 22 per cent of those responding; and 10 per cent listed "military obligation." "Undesirable working conditions" were cited by 7 per cent. A surprisingly small group, only 5 per cent, gave "better opportunity for advancement in other jobs" as their reason for entering nonteaching work. Other reasons listed infrequently were "no desire to teach," "position not available in desired location," and "continuing education."

Would they consider entering upon (or resuming) a teaching career? About 58 per cent of those responding said they would consider teaching if "conditions were more favorable." Included in this group was a considerable number of women who had dropped out of teaching because of domestic responsibilities. Another 30 per cent of those responding indicated they would not consider teaching. The other 12 per cent were undecided.

In what kind of employment are these persons presently engaged who were certified to teach science? About 18 per cent of the respondees were working in industry, frequently on assignments requiring little scientific training. About 23 per cent were housewives. Nearly 12 per cent were in military service. The others were accounted for in a variety of less-frequently-mentioned occupations: sales work, state and federal employment, self-owned business.

What are the implications? It is never safe to draw conclusions from a single study. However, within the limits of this investigation, it would appear that Louisiana high schools could be staffed with fully prepared science teachers if those educated as teachers were actually in the classrooms. Inadequate salary, unfavorable working conditions, homemaking, industry, and other fields of employment are taking heavy toll of those trained. The recruitment problem is overshadowed by that of retention. The profession is working with a sieve. Really, how many science teachers must be recruited and educated in order to have one classroom continuously staffed? Does this problem prevail to the same degree in other subject areas? And in other states? The question cannot be reduced to the simple one of how to recruit more teachers. It appears to be partly a question of "why the missing teacher."

Techniques in the Study of FRUIT FLIES

This report was an entry in the STAR (Science Teacher Achievement Recognition) program of 1960, conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

By ISADORE HALPERN

Science Teacher, Erasmus Hall High School, Brooklyn, New York

IN considering the subject of genetics, it is not uncommon for high school biology students to study the heredity of the fruit fly. Although they may use charts or even observe flies in bottles, how often do most students ever arrive at a close examination of these insects? How many have ever seen a fruit-fly egg or larva under the microscope? Moreover, how many have ever anesthetized flies for observation in the laboratory?

Materials used for fruit fly studies.

Such studies need not be relegated only to college genetics classes or assigned to the talented student as special project work. Through the use of techniques described here, it should be possible to include fruit-fly study as general laboratory procedure for all high school biology students.

Two limitations usually are present in the handling of flies. The first is the use of ether for anesthetization—a hazardous procedure for high school students. The second limitation is the students' lack of experience with observation and handling of fruit flies in various stages of development.

The first limitation is overcome by the use of a cooling technique for inactivating flies, instead of using ether or another anesthetic. Cooling is accomplished by placing a stoppered vial or bottle of flies in an upright position in a bowl of water with ice cubes. Within a minute, the flies will fall to the bottom of the vial. The process of inactivation may be hastened by tapping the vial.

If the flies are left for an additional twenty to thirty seconds, they may then be shaken out of the vial. They will, however, begin to move about quickly. To overcome this, they should be placed on top of a metal container filled with ice water. A round tin of the type used for ointment is suitable. If the surrounding air is humid, moisture may collect on the tin, but this may be removed with a cotton-tipped applicator. Flies will stay quietly on this surface for several minutes and may be examined in this position using a camel's hair brush, or the tin may be placed on the stage of a binocular microscope for observation. (See Figure 1.) The insects are then shaken into

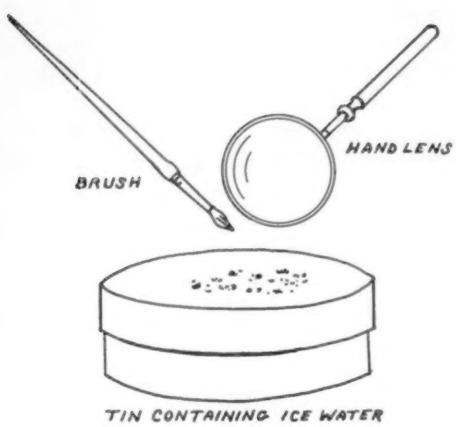


FIGURE 1.

a paper cone and returned to their vial.

The second limitation is overcome by the preparation of breeding vials for close study. The technique employed here is to place a block of food on a slide which is then inserted into a vial. (See Figure 2 a and b.) The food is prepared in the standard way and poured into a Petri dish where it hardens into a cake, and the closed dish is stored in a refrigerator. When needed, blocks of food are cut approximately 1½ by ½ by ⅜ inches and placed on the slide. A drop of yeast mixture is added to the food to promote fermentation. The vials are stoppered with cotton plugs or plastic caps which have been perforated with pinholes. The flies are placed inside, the slide containing the food block is inserted quickly, and the vial is capped. Fertile flies will begin to lay eggs soon afterwards, and within twenty-four hours, larvae will begin to emerge from the eggs. Egg-laying may be observed through the vial with a hand lens. Students find it interesting to give the same group of flies repeated cooling treatments and to watch them return to activity without apparent ill effects. Thus the cooling technique has a distinct advantage over ether in experimentation of this type.

For microscopic study, the slide containing the food block is removed after placing the vial in ice water to inactivate the flies. The cap is removed and the slide is withdrawn from the vial and examined for eggs, larvae, or pupae. One must not forget to cap the vial to prevent the flies from escaping. The cooling technique should be repeated before replacing the slide.

When the block of food is under the microscope, the eggs, larvae, or pupae may be moved or transferred with a dissecting needle or camel's hair brush, whichever can be used conveniently so as not to cause injury to the specimens.

Advantages of Techniques

It is possible to perform laboratory work at school and to take these vials home for continued study. There are no dangers involved since ether is not used. A student may devote more time to observations this way, and his interest is not interrupted. Furthermore, members of the student's family often show interest in these home activities.

Facts About Fruit Flies

1. Female flies do not mate before they are 12 hours old. Therefore, in breeding experiments, newly emerged flies from pupa cases must be separated according to sex within this period.
2. They do not lay eggs before they are 48 hours old.

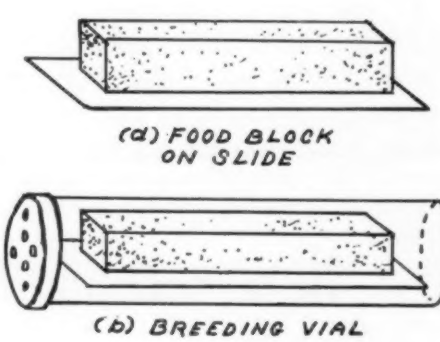


FIGURE 2.

3. Larvae hatch from eggs in approximately 22 hours. The larva stage lasts for about 7 days.
4. The pupal stage lasts for a little more than 6 days.
5. The complete metamorphosis takes about 15 days.
6. Female flies hold the male sperms in their bodies and allow fertilization just before the eggs are laid.
7. Many eggs may be laid in an hour or two on the food block, if fermentation of the food is taking place.
8. The egg is about ½ mm long; the larva may grow to 4½ mm.

Preparation of a Breeding Vial

A convenient size vial is 3 inches long by ⅞ inches in diameter. Pieces of glass for slides should be cut about 2½ inches long by ¾ inches wide. The food block is cut to approximately 1½ inches long by ½ inches wide by ⅜ inches high. A drop of yeast suspension is added to the food block before use. About five flies should be placed in a vial to insure egg-laying. Motionless flies should never be shaken into a tube containing food because their wings may be caught. If a large number of offspring is desired, the parent flies should be transferred to several vials as soon as eggs are laid on a block of food.

Preparation of Food

The formula is given in parts per 100 g or cc. I have used the cornmeal-molasses mixture.

Water	74.3
Agar	1.5
Karo or Molasses	13.5
Cornmeal	10.0
"Tegosept M" [1]	0.7

The agar is dissolved by boiling in about two-thirds of the water; molasses or Karo is added and the mixture again brought to a boil. The cornmeal is mixed with the remaining one-third of cold water and poured into the boiling agar-molasses mixture. Add "Tegosept M" and cook for a few minutes with constant stirring. The medium should be thin enough to pour easily. Other mold preventives may be used. If breeding vials are prepared and used immediately, mold inhibitors may not be needed because the larva will feed on the molds before they spread. Should any molds develop, a bit of alcohol applied with a paint brush may quickly prevent their growth.

Suggestions

A. *Experiments on Behavior and Development.* Observations may be made of egg-laying, emergence of larvae from eggs after twenty-two hours, growth of larvae, feeding behavior of larvae and adult flies, premating, and mating behavior.

Since these flies have a two-week life cycle, the complete metamorphosis of an insect may be studied in this period of time.

The responses of flies to stimuli may be studied by placing them in a glass tube about 12 inches long. (See Figure 3.) If both ends are corked, various

[1] "Tegosept M" is a mold inhibitor (10 per cent alcohol) and may be obtained from Goldschmidt Chemical Corporation, 153 Waverly Place, New York 14, New York.

foods and chemicals may be pinned on the inside of the corks to study reactions of the flies to stimuli.

The tube may also be held in various positions to determine the effect of gravity. Part of the tube may be covered to determine the effect of light.

GLASS TUBE FOR BEHAVIOR EXPERIMENTS

FIGURE 3.

B. *Genetics Experiments*. The Mendelian Laws may be studied by using flies with dominant and recessive traits —normal wing which is dominant over vestigial wing, or normal body color which is dominant over ebony body color.

Sex-linked inheritance such as white eye color may be studied.

C. *Experiments Involving the Effects of Physical Factors on Development.*

1. Experiments may be tried in which the rate of metamorphosis is affected by changes in temperature. The temperature range study may vary between 10° C and 30° C or over. Students should build their own temperature-control incubators.

2. The effect of ultraviolet light on development could be studied. One might look for mutations or the behavior of flies under various kinds of light.

3. Flies might be exposed to various doses of X rays for determining mutation rate by subjecting them to strong radiation through the glass vials.

4. Radioactive isotopes such as Phosphorus 32 or Iodine 131 in quantities of not more than 10 microcuries may be added to the fly food to determine whether mutations will occur. These isotopes are fairly safe because Phosphorus has a half life of 14.3 days, and Iodine has a half life of 8 days.

5. Variations in diet may be used to determine effects on growth and development.

6. Flies may even be placed in high or low pressure chambers to determine whether there are any changes in development. Such experiments require the ingenuity of the student, and in this age of space travel these would be timely experiments.

These are but a few suggestions regarding the kind of experimental work that can be performed with fruit flies.

Conclusion

These techniques have been suggested so that students may combine school work with experimental work at home. The techniques are simple and safe, and the experimental materials are inexpensive and not bulky. They can be carried back and forth easily between home and school.

Since fruit flies are useful as experimental animals in various areas of biological study, this writer believes they should be employed more extensively in high school biology classes.

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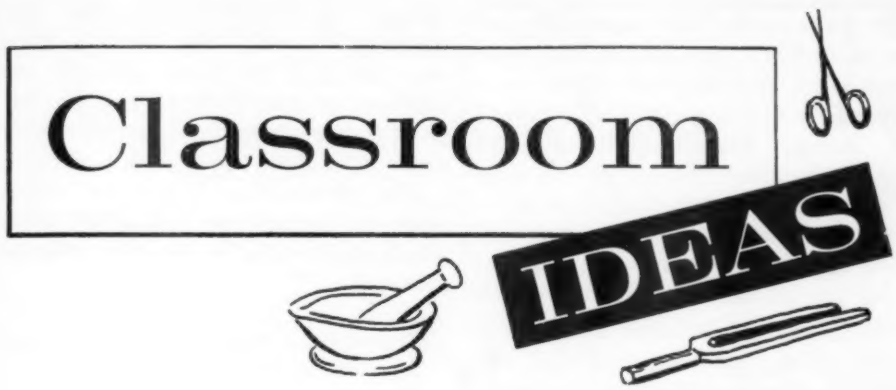
Milislav Demerec and B. P. Kaufmann. *Drosophila Guide*. Department of Genetics, Cold Spring Harbor, New York; Carnegie Institution of Washington, 1530 P Street, N. W., Washington 5, D. C. 1957.



Chemistry

Displacement of Ions

By CARMAN K. READE, Norton Senior High School, Norton, Massachusetts

The use of a new ion-exchange chelating resin[1] will vividly exhibit the ionic-exchange phenomenon between a cation in a feed solution and the chelating resin. The demonstration to follow will allow visualization of the displacement of a cation less selectively held by the chelating resin than by another cation introduced into the exchange column.

This demonstration could be introduced after the student understands chemical bonding, relative sizes of atoms and ions, factors affecting bond types, the water-softening principle, and some fundamentals of organic chemistry. The demonstration would be more effective during the latter part of the course, after the student has learned the principles involved in ion exchange.

The utility of colored ions, such as those of copper and nickel, allows the ion exchange and retardation of these cations to be easily observed as they form bands (zones) on the ion-exchange column.

The ion-exchange column consists of a 16-mm, soft-glass tube, length 16 inches, to which at one end is attached a No. 2 one-hole rubber stopper, a 3-inch, 6-mm capillary tube, a short length of rubber tubing, and a rubber hose clamp. Within the glass tube is placed a layer of glass wool, a layer of glass beads, and finally another layer of glass wool. The layers of glass wool and glass beads act as a support for the resin bed, as well as to prevent the escape of the minute resin particles from the ion-exchange column.

The resin is placed in a beaker, mixed with water to form a slurry, and poured into the exchange column until the resin bed is about 4½ inches deep upon the supporting glass wool and beads. Inasmuch as the resin must be a sodium exchanger and not a hydrogen exchanger, it is washed with one Normal sodium hydroxide solution and then with water until the effluent tests neutral.

The flow rate is controlled by the rubber-hose clamp and the stopcock of the separatory funnel. The separatory funnel contains the feed solution (influent) of cations to be exchanged. The rate of flow should be about 500 ml in 30 or 40 minutes for maximum retention on the column. The flow rate, as well as the pH of the system, is an important factor in determining the amount of cation retention.

An amount of solution, about 3 inches high, should be kept above the resin throughout the operation to prevent currents from stirring up the color bands and to prevent entrance of air bubbles into the resin bed. Air must not enter the column, and air that is lodged among the resin particles can be eliminated by stirring the resin bed with a stirring rod prior to the percolation of the influent. Squeezing the rubber tubing along its length will force the air bubbles to rise through the resin bed and escape.

To demonstrate the displacement of an ion by another in an exchange column, take 30 ml of a 0.1 Molar nickel chloride solution, dilute to 250 ml in the separatory funnel with distilled water, and percolate the solution through the resin column slowly. When the nickel solution is only a few inches above the resin column, add 15 ml of a 0.1 Molar solution of copper chloride, dilute to 250 ml in the separatory funnel with distilled water, and percolate the solution through the resin over the nickel band. The green band which was at the top of the resin bed will be displaced by a blue zone.

The reverse of the above demonstration may be performed to show that the copper cannot be displaced when a nickel solution is added.

Regeneration of the resin may be accomplished by the addition of 2 Normal sulfuric acid until all the

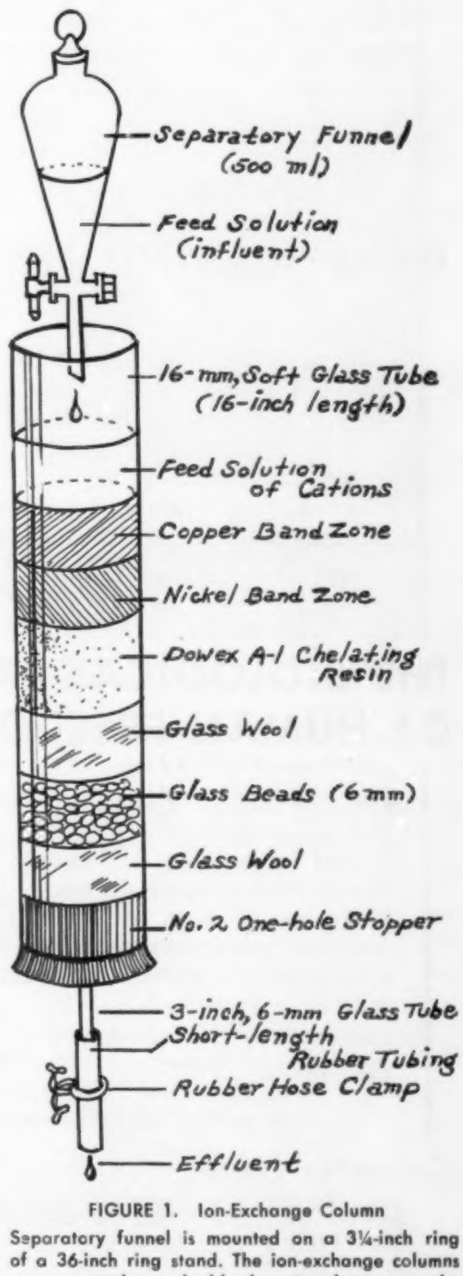


FIGURE 1. Ion-Exchange Column
Separatory funnel is mounted on a 3¼-inch ring of a 36-inch ring stand. The ion-exchange columns are mounted on double burette clamps on the same ring stand as the separatory funnel.

[1] Dowex A-1 Chelating Resin, 50-100 mesh, The Dow Chemical Company, Midland, Michigan.

cations are removed from the ion-exchange column. The resin is then put back into the basic form by the addition of one Normal sodium hydroxide and continuously washed with water until the wash is almost neutral.

The demonstrator may be called upon to discuss the following items which are involved in the ion-exchange process:

- The effect of valence on ion exchange.
- Structure of the resin.
- Hydraulic properties of the resin.
- Capacity of the resin for ion exchange.
- Effect of the flow rate on ion exchange.
- Atomic radii and ionic radii.
- Ion-exchange selectivity.
- Effect of the pH on the ion-exchange column.
- Cross linkage of the resin.
- Water-softening principle.
- Regeneration of the resin.
- Hydration.

Biology

Open-Ended Eggsperiments

By JOEL BELLER, Richmond Hill High School, Richmond Hill, New York

This report was an entry in the STAR (Science Teacher Achievement Recognition) program of 1960, conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

Working with superior children in biology presents many problems. One which vexes many teachers is how to start the first-term students on projects in which they will continue to have an active interest. The answer, I believe, lies in a living organism, one which meets the special requirements of an intelligent group of young people who have no previous experience or only limited work in biology. First, the organism should be macroscopic. Second, it must be easy to care for and relatively inexpensive. Third, it should present a number of opportunities for teaching reference throughout the year of biology. Finally, the organism must lend itself readily to a diversity of experiments, not of the cookbook type, but original, student-planned experiments.

The organism which meets these requirements is the chick embryo. It is large enough to be seen with the eye after three days of incubation. In the embryonic stage, the chick requires cer-

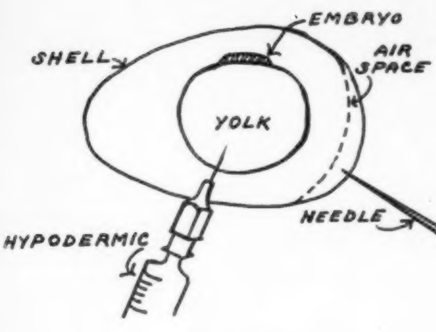


FIGURE 1.

tain conditions as temperature at 100 to 102° F and a relative humidity of 50 per cent. Both of these requirements can be met by use of an incubator containing a pan of water.[1] Fertile chick eggs may remain outside of the incubator for periods of time up to an hour without apparent adverse effect upon growth and development of the embryo. A course of study could be assigned around the chick. Respiration, reproduction, circulation, digestion, embryology, genetics, and evolution could be taught using the chick embryo for the study. Chemical substances can be introduced into the egg using sterile techniques (without allowing hazards). The eggs may be exposed cautiously to ionizing radiation.

In the fall of 1958, Richmond Hill High School introduced honor courses in biology. These courses were designed for the above-average student, and I was chosen as the teacher for one of the two honor sections. In this class my theories concerning the chick embryo were applied to the test of practicality.

It was relatively easy to interest these superior children in a series of projects designed to study the effects of chemicals and radiation upon the development of chick embryos. By speeding up the regular class work we were able to spend one period per week on projects. Later in the term, many members of the class put in extra time before and after school in addition to the class period. After the first motivating lesson, my role changed to that of a moderator, consultant, and recommender of books and other source material.

The first real task was to build an incubator. A committee of five boys completed this job at home using as a guide the plans which appeared in *The Science Teacher*[2] earlier in the year. Our incubator was constructed with larger dimensions and designed to accommodate twenty-four to thirty eggs. Through the kindness of the Memorial Sloan-Kettering Cancer Center, we were able to procure fertile chick eggs at no cost. Each batch of eggs was of the same age of incubation.

The class was organized into committees, and each committee worked to determine a different factor. The committees had to procure their own supply of experimental substances by talking to family doctors, local hospitals, drug companies, and supply houses. The chemicals used were Phosphorus 32, Iodine 131, Adrenalin, and Ascorbic Acid. The father of one of the pupils was a physician who agreed to expose some eggs to 150, 200, 250, and 300 roentgens from an X-ray machine. Two separate control committees were established. (See Table I.)

The best technique for injecting the eggs was to use a hypodermic needle

[1] Bradley M. Patten. *The Early Embryology of the Chick.* Third Edition. The Blakiston Company, Philadelphia, Pennsylvania. 1948.

[2] William P. Moser. "Elementary Science Suggestions." *The Science Teacher*, 25:210. May 1958.

and to candle the eggs at the same time. A simple candling apparatus can be made out of a desk lamp with a 100-watt bulb and a cone of black paper taped to the reflector of the lamp. The aperture of the cone should permit about one inch of the narrow end of the egg to enter. Since the embryo will always be found on the upper side of the yolk, the injection should be made into the underside of the egg through the shell and shell membranes into the yolk. Injection here will prevent accidental injury to the embryo. The injection site was first swabbed with 70 per cent alcohol to reduce the danger of fungicidal contamination. Prior to injection, a needle was used to make a hole through the round end of the egg into the air space. (See Figure 1.) The loss of the air space provided enough room for the addition of chemicals. After injection, the site was covered with Scotch tape.

Our eggs were injected five days after fertilization. The eggs were marked and then returned to the incubator. One pupil was assigned the daily task of examining the eggs and turning them. This movement insures a mixing of the chemical with the yolk. Movement will also aid in the development of the embryo.

On the seventeenth day of incubation, the shells were broken, and the embryos were removed from the yolk and weighed. The embryos were then tagged with the weight marked appropriately. Each chick was checked for bone abnormalities; none was found (see Table I). Tagging was followed by cleaning, clearing, staining, and preserving in glycerine according to the recipe below, a modification of the one by Diefenbach.[3]

Table I

Substance	*Amount*	*Egg Number*	*Weight in Grams*
Adrenalin	0.25 milliliters	1	13.6
	0.50	2	13.5
	0.75	3	10.6
	1.00	4	10.1
Iodine 131	1.25 microcuries	5	14.6
	2.5	6	13.5
	5.0	7	M*
Phosphorus 32	0.25 microcuries	8	13.6
	0.50	9	11.2
	0.75	10	10.1
	1.00	11	7.3
Ascorbic Acid	200 milligrams	12	4.8
	100	13	11.0
	75	14	M*
	50	15	9.6
X rays	150 roentgens	16	9.5
	200	17	8.9
	250	18	7.3
	300	19	6.5
Control (untreated)		20	14.0
		21	13.6
		22	14.6
Control (shell and shell membranes pierced, but nothing injected)		23	15.1
		24	16.8
		25	16.2
		26	15.5
		27	12.9
		28	M*

M* = embryo failed to develop.

Chick Preserving Recipe

1. 95 per cent alcohol—leave for one week.
   a. Eviscerate after 1 to 2 days.
   b. Replace alcohoi.
2. Acetone—one week.
3. 95 per cent alcohol—three days.
4. Potassium hydroxide (KOH)—place no more than two embryos in each jar and leave overnight. *Don't* put the tags in the KOH.
   a. Small embryos or humid weather—0.5 per cent KOH.
   b. Large embryos (use 10 g or more) or dry weather—2 per cent KOH.
5. Defeather—fill jar with distilled water.
6. Stain the day after defeathering by using a saturated solution of Alizarin Red in distilled water. Put 2 to 3 drops in 0.5 per cent KOH for each embryo.
7. Use 40 per cent glycerine to remove the excess stain. The lower the concentration of glycerine, the greater is the amount of stain removed. Leave for one week.
8. Replace with 80 per cent glycerine for 4 to 7 days.
9. 100 per cent glycerine and bottle.

One lesson was devoted to the assimilation of the data by the class. The data of each committee (see Table I) were tabulated on the board, examined, discussed, and inferences tabulated. No conclusions were made because of the small number of experimental organisms. The possible reasons for the failure of some of our embryos to develop properly were considered. Use of a poor sterile technique was accepted as the reason for failure. The homework assignment for that lesson was, "On the basis of the experiments just concluded, what shall the next phase of our experiment be?"

Some of the experiments which were or are now being performed include:

1. The effect of glutamic acid upon the development of the brains of chick embryos.
2. The effect of ultraviolet light on chick embryo development.
3. The effect of weak electric shock on embryonic growth.
4. The effect of gibberellic acid on chick growth.
5. The effect of magnetic waves of approximately 20,000 gauss on development of chick embryos.

The choice of experiments which the members of the class decided to perform convinced me that progress had been made. As I reflect upon the entire project, I take pleasure in recalling how the students changed from their first, inept attempts at mastering the art of handling the instruments and the eggs to the deft, confident movements of a research worker. In addition, there was a continued interest throughout the year to perfect their techniques.

[3] William C. Diefenbach. *Transparent Animal Specimens*. Monograph No. 3. Science Clubs of America, Washington, D. C. 1941.

General Science

A Practical "Final Exam"

By HOWARD F. MATZ, University Junior High School, Northern Illinois University, DeKalb, Illinois

Setting: a natural woodland of hardwoods and softwoods adjacent to a small fresh-water stream flowing through a rolling grassland; a farm lot nearby with corresponding buildings used basically for feeder cattle; the farm itself, following accepted conservation practices, planted in row and cover crops.

Characters: a seventh-grade mathematics and general science class of twenty-five pupils and one instructor.

This format laid the groundwork for a practical conclusion to a year's course in seventh-grade mathematics and general science. The author, an instructor in the mathematics and science department of the University Junior High School, formulated and administered this experience to the class. Students and instructor traveled to and from the area by bus, bringing their lunches, since the practical "lesson" consumed an entire day. The experience culminated in individual written exercises.

The biological sciences were utilized in the woodland scene where students moved about freely and actually identified bird life, trees, wild flowers, and insects according to the evidence found. Meanwhile, typical specimens were gathered by the instructor to be used as a culminating portion of the final examination.

The issuance of a forty-eight-inch piece of string produced the next phase. Each student was asked to place the string in a twelve-inch square anywhere in the general area he chose. He was to identify all objects in the square, naming the principles and concepts of science and mathematics he had learned in the past year. For example, one girl placed her square about two feet above the stream. Here she identified a spring, soil erosion, sorting, types of rocks, evidence of weathering, gnats, green algae, grasses, plant reproduction, parts of a flower, volume, area, symmetry, sets, subsets, and broken, curved, and straight lines.

The geologic phase was carried out effectively as the class passed along the stream bank. Terminology and principles such as sorting, flood plain, delta, bank-cutting, meandering, oxbows, effect of roots, intermittent flows, deposition, and others were utilized for recall evaluation.

A minnow and a painted turtle were used to evaluate and identify the functions and principles related to the physiology unit. A simple dissection, as well as external observation, served their purpose, and students were asked to furnish the answers to various questions supplied by the instructor.

A mathematical evaluation was conducted on the farm lot. Students were asked to name regular polygons and other geometric figures seen in the area. These were to be identified with the names of the objects, *e.g.*, the base of the windmill was in the shape of an equilateral triangle. A number of practical problems involving perimeters, areas, and the different percentages and ratios were discussed.

Free time was provided for the students to move about gathering further evidence from specimens and from the area to supplement knowledge, understanding, and appreciation gained in the past year.

In conclusion, the author feels that a final examination in the form of a field trip offered a new and valuable experience for the pupils. They not only enjoyed the day, but they lost their distaste for the final tests because they actually *saw* what they had learned. Although the evaluation is similar to that of any classroom examination where understanding is evidenced with paper and pencil, the value lies in the application of the "classroom" and the "apparatus" to the natural setting of the out-of-doors.

FELLOWSHIPS, SUMMER 1961

Shell Merit Fellowships for advanced study in chemistry, physics, and mathematics are available for the 1961 Summer Session (June 26-August 19) at Stanford University, California. Fifty fellowships will be awarded to qualified secondary school teachers who have completed applications by January 4, 1961. Each grant includes full tuition, fees, board and lodging in University facilities, and transportation and summer salary allowances. Address inquiries to: Dr. Paul DeHart Hurd, Coordinator, Shell Merit Fellowship Program, School of Education, Stanford University, Stanford, California.

BOOK Reviews

Physics and Microphysics. Louis de Broglie. Translated by Martin Davidson. 286p. $1.50. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1960.

Louis de Broglie is one of the founders of our current theories about the submicroscopic structure of matter. He is thus eminently qualified to discuss both the physics which is contained in these theories and the philosophical implications which they force us to consider. The original French edition of this book, however, was written over fifteen years ago, and while the philosophical matters which are discussed remain of great interest, included also is a large amount of factual material which has been found to be false or incomplete since that time. The author has attempted to compensate for this by including footnotes and addenda of a more recent vintage (1955). Nonetheless, unless the reader is quite familiar with all the physics involved, confusion is likely to result. These difficulties are somewhat compounded by the fact that the translator was apparently not familiar with many English technical expressions, and several misleading translations have resulted.

In spite of the above criticisms, the book is of value to anyone interested in the philosophy of quantum physics. De Broglie shows, for example, why space and time are purely statistical concepts that have no meaning in the submicroscopic domain, and how these lead to modifications of the ideas of determinism and causality. He shows how the existence of the "quantum of action" makes purely "objective" observation no longer possible. Especially to be recommended is the chapter entitled "The Grandeur and Moral Value of Science," in which de Broglie examines the *raison d'etre* for the pursuit of scientific knowledge. He raises and discusses the profound question of why man's mind functions in such a way that it is possible for it to understand *any* aspects of the universe. In a later chapter, this infrequently expressed idea arises again when de Broglie speculates whether the complete understanding of certain phenomena, particularly nuclear physics, might be forever closed to the human intellect. It must be emphasized that this speculation holds as much interest today as it did fifteen years ago.

This is a book to read and reread, for only then can the profundity of the philosophy it examines be fully appreciated.

GERALD G. OHLSEN
The University of Texas
Austin, Texas

The Encyclopedia Americana: The International Reference Work. 30 volumes. Prices (depending upon binding) $319.50 to $600, discounts to schools and libraries. Americana Corporation, 4606 East-West Highway, Washington 14, D. C. 1960.

Many reviews have been written about *The Encyclopedia Americana.* These have been extensive and have evaluated the set as a general reference. Before attempting the task of a review, this writer read as many of the past reviews as were available. None seemed to examine the set specifically in terms of its usefulness to a science teacher or a science educator. This review will attempt to do just that by answering some questions related to evaluation of the set.

Is it easy to use? A reference to the index in Volume 30 will answer this question. If a student wishes to make a report on a topic, the alphabetical index with major headings for related subjects refers him to to the volume and page for the information needed.

Does it contain current information? To test this, we asked ourselves, "What can a student find about artificial satellites and space?" Twelve references to artificial satellites and fifty-two to space are found containing current information and a complete historical resume of developments. This is typical of the treatment of other current subjects as well.

Do the illustrations help the student to understand the text? We studied a number of topics and found that the illustrations are well chosen, appropriate, and meaningful. For example, pictures of snakes are presented in halftone, black and white, and color. With increasing emphasis on earth science, an understanding of maps becomes more important today. The many maps included are satisfactory and easy to use.

Is it authoritative? The answer can only be in the affirmative. A review of the list of contributors—distinguished scholars in the physical and biological sciences—substantiates the *Americana's* authority.

Is it useful in stimulating interest in the sciences through a study of the contributions of great scientists? In this category, the *Americana* is outstanding. We find numerous biographical sketches of distinguished persons, ancient and modern, in the biological and physical sciences.

Is it helpful to a science teacher in his attempt to interest students in mathematics and its relation to science? A wealth of material on mathematics supplies the answer to this question. The history of mathematics, biographies of great mathematicians, information on advanced mathematics, and the relationship of this discipline to science are well covered.

At one time this reviewer was discussing resources with a college zoologist and two high school science teachers. The science teacher from a university city expressed his appreciation for the help of university scientists. The other high school teacher explained that he was less fortunate since his school was one hundred miles from the nearest university. The college teacher suggested that, in lieu of other authorities, this teacher use *The Encyclopedia Americana* as a source of information. This conversation impressed upon the reviewer the *Americana's* value as a resource for science teachers and their students.

H. SEYMOUR FOWLER
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Project Sherwood: The U. S. Program in Controlled Fusion. Amasa S. Bishop. 228p. $1.25. Doubleday Anchor Books. Order from Wesleyan University Press, Inc., Columbus 16, Ohio. 1960.

As reserve supplies of fossil fuels dwindle, it becomes evident that man must turn to nuclear energy sources to satisfy his ever-increasing demands. Energy from nuclear fission will not provide the ultimate source of energy. Supplies of fissionable materials are large but are nevertheless limited. The fission process produces large quantities of highly radioactive waste products for which no satisfactory long-term disposal system has been devised. It is quite possible that waste disposal problems may limit the use of fission before the fuel supply is exhausted.

Nuclear fusion, on the other hand, can utilize the enormous supplies of deuterium present to a small percentage in all sources of water. The nonradioactive fusion products will present no disposal problems. Uncontrolled fusion has been realized in the so-called hydrogen bomb. The next step requires a controlled fusion process to release energy as required.

The clear readable account in this book describes the United States effort in developing controlled fusion. The author has been intimately connected with Project Sherwood and writes from a detailed knowledge of its accomplishments and its frustrations. The book is written for the nonexpert who has some knowledge of science but who is not familiar with the details of plasma dynamics. Appendix material and a glossary will be useful for those readers who are making their first acquaintance with the field.

Although the project is described through June 1959, a comparison with the report of the March 1960 Congressional hearings indicates that the work is essentially up to date. The book is highly recommended to anyone interested in this important aspect of nuclear fusion.

HOWARD L. ANDREWS
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Bethesda, Maryland

The Centrifuge

The Future Scientists of America newsletter titled "The Centrifuge" will make its debut early in 1961. This informative report will be sent to each FSA chapter free of charge. The main function of "The Centrifuge" will be to disseminate news of the people and activities associated with the new youth organization. Brief accounts of noteworthy activities on the part of schools, sponsors, or individual FSA members will be reported, and it is hoped that useful intercommunication among sponsors, chapters, and students within chapters will evolve from the distribution of "The Centrifuge."

Sponsor's Guidebook

The first edition of the *FSA Sponsor's Guidebook* is currently being distributed, and a committee is being formed to produce a new section dealing with student projects. The project suggestions included in this new section will be abstracts derived from student reports entered in the 1960 annual awards program (FSAA), operated for the past nine years by NSTA. The new section of the *FSA Sponsor's Guidebook* will be divided into categories, each one to cover a different field of science. Examples of these are general science for the junior high schools, and for the senior high schools—earth science, biology, chemistry, and physics. Approximately fifty abstracts will be included in each category. These abstracts will be of value to sponsors when recommending science projects to their students. Each abstract will give an insight into the selection process used by the student to choose his project. Also included will be condensed but informative explanations of the project work done by the participant.

FSA sponsors are requested to write suggestions or send in new material which might become an appropriate part of the *FSA Sponsor's Guidebook*. During the year information concerning research or projects which may come to anyone's attention will be welcomed and appreciated. Active chapters are entitled to receive all such guidebook supplements free of charge by virtue of payment of the yearly renewal fee prescribed by FSA. Submit your recommendations by simply writing them on a postcard addressed to Mr. William P. Ladson, Director, FSA, 1201 Sixteenth Street, N. W., Washington 6, D. C.

FSA Youth Organization

Increased interest in the FSA Youth Program has resulted in numerous requests for more information to be presented to members through NSTA regional meetings. It has been feasible to send an NSTA staff member to participate in recent meetings and describe the FSA program in its entirety. This arrangement, however, is not always possible due to time limitations and other staff responsibilities. Therefore, NSTA headquarters will send material or details on the program to members who wish to engage in a planned presentation of the FSA program at any future conference or meeting. Just write about your plans directly to FSA, NSTA headquarters office. When possible, personal assistance or attendance at these meetings will be arranged.

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST*'s calendar editor as early as possible.

December 26-30, 1960: NSTA Annual Winter Meeting in conjunction with 127th meeting of the American Association for the Advancement of Science, the Roosevelt Hotel, New York City.

February 1-4, 1961: Annual Meeting, American Association of Physics Teachers, Hotel New Yorker, New York City

February 22-25, 1961: 34th Annual Meeting, National Association for Research in Science Teaching, Pick-Congress Hotel, Chicago, Illinois

March 24-29, 1961: NSTA Ninth Annual National Convention, Hotel Sherman, Chicago, Illinois

The First of Fifty

The charter for the inaugural chapter of the Future Scientists of America, reported in the November 1960 TST, was accepted for University High School at The State University of Iowa by Professor James A. Van Allen, physicist at the university. William Fischer (center), University High School sophomore, is the first president of the new group, named the Van Allen Chapter in honor of the head of The State University of Iowa department of physics and astronomy. William P. Ladson, NSTA (far left), went to Iowa City to present the charter as director of the Future Scientists of America. Robert E. Yager (far right) and John Bolte (second from right) are faculty sponsors of the Van Allen Chapter. Dr. Yager is also a regional director of the program.

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee

Chairman: Dr. H. Seymour Fowler

The Pennsylvania State University, University Park, Pennsylvania

BOOK BRIEFS

Successful Devices in Teaching Chemistry. Paul Westmeyer. 260p. $3 to schools. J. Weston Walch, Publisher, Box 1075, Portland 1, Maine. 1959.

In this paper-bound manual the author proposes a method for teaching chemistry through the emphasis of laboratory work. Also included is a broad range of demonstrations, experiments, and projects, many of which were submitted by teachers in the field. A good demonstration reference. Especially valuable for new chemistry teachers.

Lecture Experiments in Chemistry. G. Fowles. 634p. $6.50. Basic Books, Inc., 59 Fourth Ave., New York 3, N. Y. 1959.

A book of chemistry demonstrations suitable for high school or freshman college classes. The demonstrations appear to be basic to good chemistry teaching. Included also is a section on aims and methods of teaching this discipline.

And There Was Light. Rudolf Thiel. 384p. 75¢. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1960.

An excellent history of the development of astronomy and astrology through the ages. Packed into this book is a wealth of information accompanied by illustrated plates, excellent photographs, and tables. The work of the contributing scientists is well done and informative. Recommended for the advanced high school student.

A Book of Moon Rockets for You. Franklyn M. Branley. 64p. $3. Thomas Y. Crowell Company, 432 Fourth Ave., New York 16, N. Y. 1959.

A book designed for children from grades four to eight. The content deals with the problems of attempting a space probe to the moon and how a man might be sent to the moon.

Numbers Old and New. Irving and Ruth Adler. 48p. $2.19. The John Day Company, Inc., 210 Madison Ave., New York 16, N. Y. 1960.

A lucid and well-illustrated book for young mathematicians in the intermediate grades. The volume contains a brief history of numbers and number systems, some interesting number games and innovations, and a variety of ways of working with numbers that should challenge the brighter child. Recommended for supplementary reading in the elementary school arithmetic program.

Facilities and Equipment for Science and Mathematics. W. Edgar Martin. 130p. $1. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 1960.

A paperback publication which describes and compares official requirements and recommendations of state departments of education in regard to facilities, equipment, and instructional materials for science and mathematics at both elementary and secondary levels. Many charts and room plans are included. Excellent source of ideas for those planning new facilities.

Teaching Machines and Programmed Learning: A Source Book. Edited by A. A. Lumsdaine and Robert Glaser. 736p. $7.50. Department of Audio-Visual Instruction, National Education Association, 1201 Sixteenth St., N. W., Washington 6, D. C. 1960.

A collection of the major papers on teaching machines and programmed instruction is contained in this source book. Begins with the work of Pressy in 1926 and continues through current developments in this new dimension of teaching and learning. In addition to the planned articles, significant contributions on this topic appearing in other education journals have been included to provide a comprehensive and useful source document. Throughout the work is reflected the concept that the processes of teaching and learning can be made an explicit subject matter for scientific study on the basis of which a technology of instruction may be developed.

In a 28-page summary, it contains research abstracts and a comprehensive bibliography of value to teachers and research specialists.

The Chemical History of a Candle. Michael Faraday. 102p. 95¢. The Viking Press, 625 Madison Ave., New York 22, N. Y. 1960.

This is a work that should be of particular interest to high school chemistry or physics students. Included is an interesting compilation of six lectures delivered by Faraday on a subject of great importance at that time. Although the concepts are well known today, the book shows the logic of Faraday's research.

Discovering Dinosaurs. Glenn O. Blough. 48p. $2.50. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. 1960.

This attractively illustrated book tells the story of reptiles that once roamed the earth. Contains good development of the geologic-time concept and a clear description of the work of paleontologists. Recommended for middle elementary grades.

The Exploration of Space. Robert Jastrow. 160p. $5.50. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y. 1960.

A high-powered account of current space investigations in the form of a compilation of papers delivered at a recent symposium by leaders in space research. Included are articles about the moon, solid particles in the solar system, corpuscular radiation, and others. This would be a useful source of information for talented high school students.

A Firsthand Report on Soviet Schools. 64p. $1. Division of Travel Service, National Education Association, Washington 6, D. C. 1960.

Report of a trip through the Union of Soviet Socialist Republics by a group of sixty-four American educators. Chapters deal with nearly all aspects of the educational program such as curriculum and methods of teaching, teacher education, administration, school construction, adult and correspondence offerings, and others. Science teaching is adequately considered and reported in total concept, not as an area apart. Over-all impression is that this report is factual, critical, and objective, as well as interesting, in its appraisal of strengths and weaknesses of USSR schools.

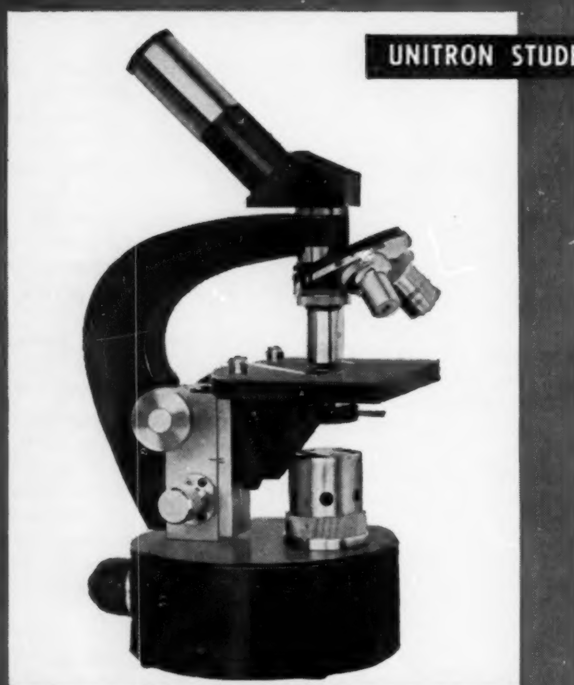
What Does a Civil Engineer Do? Robert Wells. 64p. $2.50. Dodd, Mead & Company, 432 Fourth Ave., New York 16, N. Y. 1960.

Informative vocational guidance booklet. Deals with historical development of the profession of the civil engineer and portrays the multiple work areas of this field, giving students a basic understanding of it. Illustrated with photographs.

Tested Demonstrations in Chemistry. Hubert N. Alyea and Frederic B. Dutton. 168p. $3. Chemical Education Publishing Company, 20th and Northampton Sts., Easton, Pa. 1960.

This treatment of chemistry as a demonstrative science will be of value to all chemistry teachers. It is as complete a work as has

UNITRON student microscopes offer



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Model MUS-ND: As above but with two objectives: 10X, 40X; single 10X eyepiece.

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ever been produced. It deals in some way with each facet of the science needed in a secondary classroom. Incorporated are safety rules, danger signs, additional information about complex demonstrations that are seldom contemplated in high school, and a complete index. The book will be of assistance to all chemistry teachers as both an instructional aid and a resource piece.

A Basic Book Collection for Elementary Grades. Miriam S. Mathes, Editor. 136p. $2. American Library Association, 50 East Huron St., Chicago 11, Ill. 1960.

Provides a well-balanced list of 1020 books for the elementary school library. Arranged by author, subject, and title. Includes also a list of magazines for elementary grades.

A Basic Book Collection for Junior High Schools. Margaret V. Spenger, Editor. 136p. $2. American Library Association, 50 East Huron St., Chicago 11, Ill. 1960.

This list of 1069 books will serve as an aid in selecting new books and as a check list for evaluating school libraries. Arranged by subject, title, and author.

Free and Inexpensive Learning Materials. Tenth Edition. Division of Surveys and Field Services, George Peabody College for Teachers, Nashville 5, Tenn. 1960.

This 252-page publication contains discussion of widely diversified topics ranging from cancer to Communism and from sewing to science. The names, addresses, and costs, if any, of all enclosures are given in detail. If a publication series is mentioned, all titles are incorporated.

The book would be invaluable to the teachers as a resource material and can be obtained for $1.50.

Natural Resource Use in Our Economy. William H. Stead. 88p. $1.25. Conservation and Resource Use—Education Project, Joint Council on Economic Education, 2 West 46th St., New York 36, N. Y. 1960.

Describes the present outlook for our resources and outlines the responsibility of government, business, and the individual citizen. Learning activities are given for primary and elementary grades and the junior and senior high school.

Science for Children. Muriel Mandell. 96p. $2.50. Sterling Publishing Company, Inc., 419 Fourth Ave., New York 16, N. Y. 1959.

Every page is filled with simple, inexpensive, but very effective experiments in the fields of Air, Water, Mechanical Energy, Machines, Heat, Sound, Light, Magnetism, and Electricity. Helps build basic science concepts with children. Experiments illustrated with sketch diagrams. Suitable for upper elementary use.

Under a Green Roof. Anne Marie Jauss. 64p. $2.95. J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pa. 1960.

An authoritative introduction to the forest community and to the lives of the animals that live therein. Although mammals are stressed, some members of other vertebrate groups are also mentioned. The general and simple form of presentation and the numerous black and white drawings make the book useful for elementary students.

Admiral Richard E. Byrd. Alfred Steinberg. 128p. $2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1960.

A well-written biography of Admiral Byrd. Builds on boyhood anecdotes which led to his success as an explorer. Takes the reader into the planning, organization, and execution of his polar explorations. Excellent general reading material for junior-senior high school science and social science.

Jeff Carson, Young Geologist. John and Jane Lemish. 212p. $3. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1960.

Written for junior or senior high students desiring information on a career in geology. Careers in economic geology, petroleum geology, and geophysics are portrayed in story form through the experience of a young college student trying to decide on the opportunities open to him in the field of geology.

A Beginner's Guide to the Skies. R. Newton and Margaret Mayall. 184p. $2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1960.

Intended to help the observer become better acquainted with the night sky and to serve as an introduction to a more difficult treatment of the heavens. The star charts, however, are not as simple as they might be for the age group intended. Contains a good presentation of what may be seen with binoculars. Constellation data are adequate with good explanations of star color and magnitude. Upper elementary and junior high students will find the book useful but not unusually inspiring.

PROFESSIONAL READING

Selected Science Books for Secondary Schools. Connecticut Science Teachers Association. 1960. A valuable annotated study for the secondary science teacher of available books in science and science careers, with an all-inclusive price range. The books included in this bibliography are indexed by grade level as well as subject and title and are evaluated on the basis of purchase priority, if funds are limited. Available for 35¢ from the CSTA Bibliography Committee, Central Connecticut State College, New Britain, Connecticut.

"Quality Science for Secondary Schools." *The Bulletin of the National Association of Secondary-School Principals,* 44. December 1960. The subject topic of this issue has been prepared by a special committee of the National Science Teachers Association. The contents define attitudes and understanding that science teachers need if they are to

engage effectively in planning and directing improvements in science programs. The role of the secondary school principal in improving these science programs is stressed, since the stimulus for improvement often must come from the administration of the school. Emphasis is on the improvement of the quality of science education rather than the quantity of material in the curriculum. (Republished in book form, see p. 68.)

"A Study of the Relationship of Fundamental Skills Measured by the National Merit Scholarship Qualifying Test to Natural Sciences Reading Ability." By Billy G. Aldridge and Kenneth E. Anderson. *School Science and Mathematics,* 60:439. June 1960. This study was designed to discover how four fundamental skills affect reading ability in the natural sciences. It indicated that ability in word usage was most important, and that the other skills, in decreasing order of importance, were abilities in social studies and mathematics usage. English usage (punctuation, diction, and organization) did not contribute significantly.

"Improvement of Instruction in California High Schools." By Frank B. Lindsay. *AIBS Bulletin,* 10:23. April 1960. A description of how science, mathematics, and modern foreign language specialists are used to improve teaching techniques.

"Caveat Emptor: An Old Problem Made New by NDEA." By Ralph P. Frazier. *School Science and Mathematics,* 60:503. October 1960. The National Defense Education Act in providing money for purchase of equipment calls for a sound investment of these funds to bring maximum educational dividends.

"Needed: A Radical Change." By Harold Hawe, Ind. *Saturday Review,* 73. September 17, 1960. Schools of the future will need to question all past practices. Particularly at the secondary level will they need to take into consideration the student's ability to educate himself.

"College Physics in Transition." By Frank Verbrugge. *Physics Today,* 13:28. September 1960. College physics teachers are concerned with a new plan for developing a coordinated nationwide program for improving physics education. The American Association of Physics Teachers recently sponsored a special conference to plan for this program. This article gives an account of the meeting and plans for the future. The meeting represents the beginning of what will be in all probability an important program, and the article is therefore recommended for reading by science teachers.

"The Methods of Science: Dreamers and Tappers." By David Bergamini. *Think,* 26:7. September 1960. Theoretical science and experimental science are becoming less clearly defined as separate activities in the field. This article shows how the scientific advances of the twentieth century have caused the two principal figures in the field of science, the experimentalist and the theoretician, to work closely together. The work of the American theoretician is also reviewed.

"Discovery of Interference by Thomas Young." By Robert W. Pohl. *American Journal of Physics,* 28:530. September 1960. A brief description is given of how Dr. Thomas Young, an English physician, discovered the principle of interference. The article shows the progress of Young's work from 1801 to 1817 when he outlined the theory of the interferometer. The effect of the work of Newton, Hooke, Ritter, and others on the principle of interference is also discussed.

"How To Get a Free Education in Science." *Space World,* 1:27. July 1960. An informative article dealing with the receipt of financial assistance by college students who are pursuing a scientific degree. Included are the names and addresses of some foundations, institutions, and other organizations having scientific educational scholarships available and the persons to whom letters of inquiry should be directed.

"Magazine Report." Division of Press and Radio Relations, National Education Association, 1201 Sixteenth St., N.W., Washington 6, D. C. Published in October, January, April, and July, this new quarterly compiles, catalogues, and summarizes full-length articles on education which have appeared in such popular mass magazines as *Time, Life,*

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"The Federal Government's Role in Support of Education, No. 1." By Hubert H. Humphrey. *Phi Delta Kappan,* 41:297. April 1960. The senior senator from Minnestota answers questions on expansion of federal support, the Murray-Metcalf Bill, and the priority of education legislation.

"The Federal Government's Role in Support of Education, No. 2." By Richard M. Nixon. *Phi Delta Kappan,* 41:349. May 1960. The Vice President of the United States gives reasons for his negative vote on federal aid to education.

"Studies in Teacher Education." Science Teaching Improvement Program, American Association for the Advancement of Science, Washington 5, D. C. 1960. A series of preliminary reports on new teacher-education programs for prospective college, secondary, and elementary school teachers.

"Study on the Use of Special Teachers of Science and Mathematics in Grades 5 and 6." Science Teaching Improvement Program, American Association for the Advancement of Science, Washington 5, D. C. 1959. Schools in four cities are taking part in the study of existing special-teacher organizations in order to determine preferred administrative procedures. This is a preliminary statement of the study.

AUDIO-VISUAL AIDS

Science Opens New Doors. A filmstrip in the *New York Times* Current Affairs series. Covers recent advances in medicine, chemistry, electronics research, space research, and nuclear energy. Shows photographs from the *Times* that will be of interest in current events as well as in science. A teacher's manual is included of a convenient size for storage, with filmstrip, in a small mailing tube. Recommended for senior high school science classes. 59 frames. B&W $2.50. 1959-60. Office of Education Activities, *The New York Times,* Times Square, New York 36, N. Y.

How We Save Water. Shows the steps in the process of bringing water from its source in the mountains to the faucet in the home. The story opens with a youngster trying to coax his dog into an outdoor bath. The source of the water used by the boy is melting snow. Film demonstrates how melting snow is either collected in reservoirs or allowed to seep into the soil to recharge the underground water supply. Though regional in its setting in Southern California, film would be of interest in other areas since it shows specialized water conservation measures peculiar to a specific region. Recommended for grades 6-9. 10 min. Color $100, B&W $50. 1959. Bailey Films, Inc., 6509 De Longpre Ave., Hollywood 28, Calif.

APPARATUS & EQUIPMENT

Allison Prop-Jet Engine. This four-color plastic model, when assembled, is 16 inches long and made to scale. The booklet which accompanies the kit describes the story behind prop-jet power and the history of the development of the jet engine. Includes a fine glossary of terms. A quiz and a list of suggested group and individual activities are also included. The instructions for assembly of the component parts are complete and detailed. The kit would make an excellent addition to the hobbyist's collection and would be of value for individual or group projects in general science. Manually operated version $4.98, battery motorized version $5.98. Prices to schools $4 and $4.80 respectively. 1960. School Service Department, Revell, Inc., 4223 Glencoe Ave., Venice, Calif.

Volume 27, THE SCIENCE TEACHER

Index—February through December 1960

The annual index is designed to be functional and space-conserving. Listed alphabetically by authors, the individual articles are coded according to topic category in bold-face figures. The key to the codings appears at the bottom of each page.

(1) Conservation (2) Education of Science Teachers (3) Elementary School Science (4) Experiments, Demonstrations, and Pupil Projects and Activities (5) History, Philosophy, Goals, and Objectives (6) Information for Science Teachers (7) Instructional Suggestions, Methods, and Materials (8) Investigations, Research, and Fact-finding Studies (9) Science Clubs, Fairs, and Exhibits; Science Talent Searches (10) Science Course Content, Organization, and Curriculum

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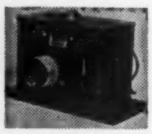

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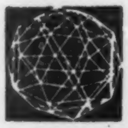

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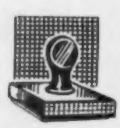

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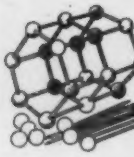

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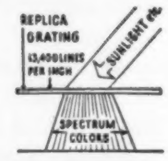

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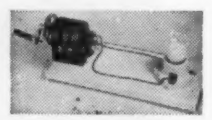

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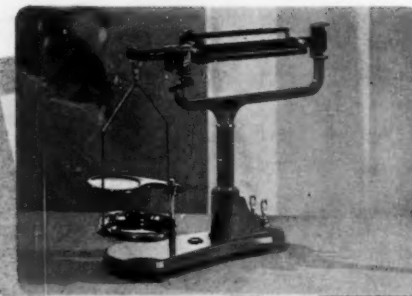

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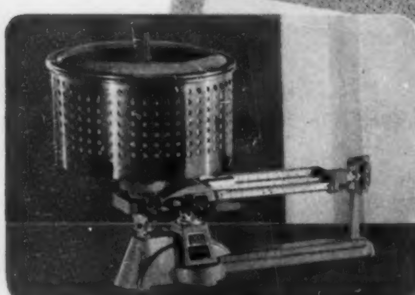

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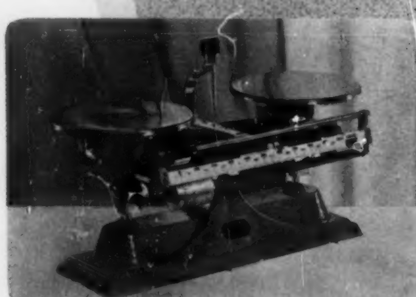

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